TECHNOLOGY TRANSFER TO CHINA

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Foreword

Momentous changes continue to occur in China. The high priorities now accorded economic modernization and improved global relationships present a sharp contrast to the years of the Cultural Revolution and earlier. Yet there is great uncertainty over China's future course. China may be a constructive trading and strategic partner, or it may choose a more divergent path. U.S. decisions on technology transfer will be an important determinant of which path is followed and the implications for the world.

This report responds to requests from the House Committee on Energy and Commerce and the Senate Committee on Banking, Housing and Urban Affairs for an assessment of the economic and strategic implications of technology transfer to the People's Republic of China and of Congressional actions that would affect it. In addition, the Senate Select Committee on Intelligence endorsed the study request.

The first phase of this study focused on energy. A Technical Memorandum, *Energy Technology Transfer to China*, was released in September 1985, and proved useful in the Congressional debate on the nuclear cooperation agreement.

This document analyzes the factors in China that affect technology transfer and will be affected by it. The experiences of U.S. and foreign companies in the China market are described. We discuss the evolution of China's economy, polity and foreign policy, and how different expectations suggest different policies for the U.S. Government.

In the course of this assessment, OTA drew on the experience of many organizations and individuals. We appreciate the assistance of the project's contractors who prepared much of the background analysis, the U.S. Government agencies and private companies who provided much valuable information, the Chinese institutions which facilitated the visits of our researchers, the project's advisory panel and workshop participants who provided guidance and review, and the many additional reviewers who helped ensure the accuracy and objectivity of this report.

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Chapter 1
Summary

Photo credit: Eric Basques

Bronze Crane in the Forbidden City in Beijing.
The crane is a legendary symbol of long life.

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Chapter 1

Summary

A billion people! If they each buy just one . . .
If we give them technology, they'll be just like Japan . . .
In a country that can launch satellites, why is the plumbing so bad . . .
All they want is technology, and they expect miracles from it . . .
It's completely different now. It's hardly even Marxist . . .
So where are all those Red Guards now? Aren't they just waiting . . .
If we don't sell it to them, France or Japan will . . .
They'll pin down the Russians on the Eastern front . . .
How do we know they won't use it against Taiwan—or us . . .
There's a lot we can learn from them . . .

China evokes countless, often contradictory, expectations and impressions. What is clear is that China will become increasingly important to the United States over the next several decades. Its impressive economic growth in recent years, if continued, will propel it into the ranks of the newly industrialized economies of Asia—Taiwan, South Korea, Hong Kong, and Singapore—but eventually on a much larger scale. International trading patterns are likely to change dramatically as China increases both imports and exports. China will also acquire increasing political influence in world affairs as its economic, technological, and military strengths grow. U.S. interests in Asia will be profoundly affected by China's international role, including its relations with the Soviet Union, Taiwan, and other neighbors.

As important as these developments are, the U.S. ability to influence them is limited. China's economic growth is much more dependent on internal Chinese factors than on any U.S. actions, and China will play its international role on the basis of its own perceived best interests. What the United States can do is reinforce China's constructive choices and trends, and protect itself against the risk that Sino-American interests will again diverge.

One of the most important influences that the United States has is technology transfer. China recognizes the need to acquire new technology and new capabilities in its efforts to modernize and expand its economy. This need was one of the main reasons for ending its self-imposed isolation and for opening itself to the West in the 1970s. The United States benefits insofar as China is a strategic asset, if not an ally, in the global competition with the Soviet Union. Technology transfer helps build these ties and increases China's strength vis-à-vis the Soviet Union. It also can lead to important commercial ties and to the export of American products. In addition, China is still a very poor country, and technology transfer can be an important element in humanitarian efforts to help a billion people move out of poverty.

U.S. policy toward China for the past 10 years has been predicated on the assumption that closer relations are generally beneficial but that caution must be exercised in the transfer of advanced, sensitive technology. This policy has had some success: China has played a more constructive international role, and many areas of common interest (reportedly including sensitive intelligence gathering) have been found. Trade has also become significant. With so much gained, some ask whether further steps are warranted—in particular, whether the United States should make greater efforts to help China modernize through technology transfer.

However, the reasons for caution have not been eliminated, and some observers feel that U.S. policy has gone too far: that China is a potential adversary, with an alien ideology and an unstable, unpredictable political system. Others see China as a newly industrializing country that is rapidly upgrading its production technology and agressively seeking international markets, becoming another, potentially much more powerful, Japan or Korea. Both views suggest great caution with respect to technology transfer.

It is the intent of this assessment to put these views into perspective and to contribute to a reexamination of U.S. policy toward China. The assessment evaluates the economic, political, and strategic implications of technology transfer to China in the context of China's capabilities and evolution. It reviews the U.S. commercial and governmental role in technology transfer, and the policies and practices of other countries. It asks whether the application of U.S. policy has been consistent with the overall guidelines, and analyzes policy options for Congress in the areas of export control, trade promotion, and military cooperation.

As used in this assessment, *technology transfer* is a process whereby a government, company, or institution provides the information necessary for China to improve its capability to design or produce goods or services. It may or may not involve the sale of equipment, but it almost always involves exchanges of information between people. Technology transfer may involve the transfer of sophisticated equipment, training in its use and maintenance, and information on design or manufacture. Indirectly, it may include the teaching of technology and management in universities. Commercial technology transfer can be accomplished through sales of equipment or expertise, licensing agreements, direct sales of information, or investments in China. The U.S. Government transfers technology by granting access to information (e.g., the U.S. National Technical Information Service) and through agency-to-agency agreements.

Technology transfer can provide some of the keys China needs to meet its modernization goals. Modernization, in turn, will enhance China's position as an exporter and will eventually enhance China's military strength. The positive and negative implications for the United States can be estimated only imperfectly. The following sections summarize the critical factors.

CHINA'S NEED FOR TECHNOLOGY

China has considerable technological capability already, especially compared with that of other developing countries, but progress has been very uneven. Military industries in particular have been favored with priorities for investments and personnel. Some of these industries have developed "pockets of excellence" that can compete in world markets. For example, China has built and launched its own experimental communication satellites and has offered to launch foreign satellites. The military sector has now been ordered to help the civilian sector, especially since many military factories are underutilized because of the recent lowering of defense budgets. **If this expertise can be used effectively, it may have a substantial impact on civilian production and exports.**

Much of China's civilian technology is out-of-date, if not obsolete. The Seventh Five-Year Plan (1986-90) has set the acquisition of technology as a high priority, especially in the fields of transportation, electronics and computers, telecommunications, and energy. The plan calls for importing much of this technology. One of the "Four Modernizations"—the policy program for development—was to raise the level of science and technology. The others—agriculture, industry, and defense—also to a large degree depend on improvements in technology. Some of these improvements could be accomplished by the purchase of modern equipment without technology transfer, but China has limited funds for imports. China could develop some technologies independently, but in general this would be much slower and less efficient than acquiring them from abroad.

China has ambitious goals, including a quadrupling of the 1980 industrial and agricultural output by year 2000. Progress so far has been above that rate (about 7 percent), primarily because a loosening of controls has freed a latent strength in the economy. New technology has made only a minor contribution but will be of increasing importance in the future. Goals for economic growth will not be met without improved technology to modernize industry and to alleviate constraints in energy, transportation, and communications.

Technology transfer can foster not only an increase in production, but also an increase in the quality of products. Modern industrial equipment can easily surpass the quality levels of the antiquated equipment typical of Chinese factories. Exposure to modern management practices, which technology transfer often entails, broadens the Chinese manager's concepts of what can be accomplished and how. Coupled with these new tools has been the realization of the need for quality in products if China is to compete well enough in world markets to earn the foreign exchange to continue buying technology.

However, China's modernization does not yet appear to have reached the point where improvements in one sector lead to improvements in others. There have, of course, been many examples of successful assimilation of specific technology transfers, but there have also been many cases of failure or incomplete success. For instance, computers and other modern equipment sometimes remain unused because of a lack of expertise or an adequate supply of a necessary input, such as electricity.

The question is not whether China is capable of modernization, but whether it is willing to make enough of the changes required for continued, rapid modernization. Like other centrally planned economies, China developed a pattern of decisionmaking that discourages efficiency and innovation, and gives the management of a productive enterprise few incentives to improve. The economic reforms that have been initiated since the Cultural Revolution have been directed at providing workers and management with incentives to increase output and quality and to improve economic decisionmaking. Measures taken include increasing the autonomy of enterprises, allowing them to retain and reinvest earnings, freeing up some markets, loosening price controls, and reducing the role of the Chinese Communist Party. Reforms have been successful in agriculture but less so in industry. Delays in price reform and opposition by those fearing loss of their power have slowed improvements in efficiency.

China's "Open Door" policy is closely related to economic reforms and is intended to facilitate technology transfer and trade. Under this policy, economic zones and coastal cities have been opened to foreign investment, and joint ventures and cooperative manufacturing have been encouraged.

To date, however, the results have been somewhat disappointing. Investments have been lower than expected, and many problems have been encountered, including high costs, shortages of skilled workers and supplies, and unfamiliarity with quality and scheduling requirements. Moreover, most enterprises are risk-averse, and the incentives for new capabilities may be weak if other constraints (e.g., energy or materials) limit production in any case. **Delays and uncertainties caused by the intricacies of Chinese bureaucracy have been particularly frustrating for outsiders trying to do business.** Although the Ministry of Economic Relations and Trade (MOFERT) was established to facilitate trade, the process is still cumbersome and full of pitfalls. If new technology is sought, approval may be needed from both the local authorities and several agencies of the central government, depending on the enterprise, the priority of the technology, and the cost.

The shortage of foreign exchange has become critical over the past year. Unlike many developing countries, China has refused to go heavily into debt, and it has had many competing requirements for its declining foreign exchange reserves. Decisions on which technologies to import are now frequently biased by considerations of how much foreign exchange can be earned rather than by how much the Chinese economy would benefit. Petroleum technologies have been particularly favored because petroleum is one of the most important exports, even though infrastructure (e.g., electric power, transportation, communications) inadequacies have been much more of a constraint on the economy.

Despite many problems, China's economy is growing very rapidly and that is likely to continue. There is also evidence that the technology transfer process is improving, and that modernization will benefit considerably.

THE U.S. ROLE IN TECHNOLOGY TRANSFER

Most technology transfer from the United States is from private companies. Although most U.S. firms approach the China market with the intent to sell products, many find they must include technology transfer if they wish to gain access to the China market. The variety of experiences are illustrated by the following examples:

- General Electric won two large orders for locomotives in part by a willingness to transfer the technology of materials and manufacture. G.E. is not setting up any manufacturing facilities in China, though an important part of the contract stipulated that China would produce several of the parts for the locomotives. The first contract took several years to negotiate. The second needed only a few months, largely because trust had developed among the participants. G.E. was also flexible in tailoring the locomotive design to Chinese requirements.
- American Motors established a joint venture with the Beijing Automotive Works to produce AMC's Cherokee model. Initial production has used parts sent from the United States. The intent was to increase the local content as rapidly as possible, but China has been unable to produce parts and supplies in the quantity and quality required. As a result, costs are high and export of the Cherokees has been impractical. China's foreign exchange crisis interfered with the purchase of U.S. parts, leading to a shutdown of the plant for 2 months, though a compromise has allowed restart.
- McDonnell Douglas has started coproduction of 25 MD-82 twinjet transports with the Shanghai Aviation Industrial Corp., following a sale of 5 to China. The planes are being produced partially under the direction of Americans, with the first plane expected to fly in 1987. Training will also be provided for the Chinese in the United States. The planes are to be certified for airworthiness by the U.S. Federal Aviation Administration, which provides an explicit standard for quality control.
- There have been no commercial satellite telecommunication sales despite two sets of proposals by U.S. and European companies. The Chinese received considerable technology transfer for free as a result of these proposals, but that probably was not their intent. Rather, China's conflicting priorities and bureaucratic power struggles, combined with the shortage of foreign exchange, have delayed a decision. China has launched two geosynchronous communication satellites of its own design, but both were relatively unsophisticated. It is unlikely that China's own products will be competitive for several decades, even with imported technology. The parallel effort on rockets is much more competitive, especially since the U.S. and European programs are temporarily inoperative because of accidents.
- IBM has been very successful in selling computers to China, but has not yet initi-

Photo credit: General Electric

A General Electric Co. locomotive pulls a train near the Great Wall. GE's locomotive contracts have included technology transfer in the form of training and information.

ated any manufacturing. Technology transfer has been largely limited to training in the use of computers. IBM may be in a unique situation to resist pressures for investment in China because of its dominant role in the international computer industry.

- Wang Laboratories is preparing at least one joint venture for the assembly and eventual manufacture of microcomputers. Included would be engineering, managerial and manufacturing expertise, software diagnostics, and after-sales techniques. This effort would complement Wang's sales to China and its manufacturing in other countries. However, Wang is concerned about China's lack of experience with large-scale production and the difficulty of maintaining quality control.

One hallmark of these cases is the lengthy negotiations. Wang started in 1980, and negotiations are only now coming to a conclusion. The McDonnell Douglas agreement took 10 years. The satellite proposals started in the late 1970s, with no commercial results yet.

China's shortage of foreign exchange has become a critical problem in cases such as AMC's joint venture. The import of supplies and the repatriation of profits are difficult. Recent Chinese regulations require foreign ventures to export or supply advanced technology in return for access to China's market. In many cases, however, the quality of the goods produced is not up to international standards, which greatly limits exports.

In addition, taxes and unexpected expenses have made China one of the most expensive

places in the world in which to do business. A company usually cannot hire its own employees; they are supplied by the state at a cost far higher than their actual salaries, and they cannot easily be replaced if they are incompetent or are transferred by the state. One of the main advantages of manufacturing in China—low-cost labor—is thus lost. Chinese managers also tend to be very cautious and frequently seem to lack a spirit of innovation.

High costs and bureaucratic rigidities are particularly difficult for small companies to manage. Few can afford to have a representative in China or continue negotiations for extended periods. Small companies are also particularly disadvantaged by complex export controls. However, some small companies have established profitable niches, particularly in the sale of specialized equipment.

Overall, businesses report mixed results in China. Some have lost money on early ventures, in the hope of building a profitable, long-term relationship, only to find China turning to competitors or dropping those imports altogether. **The investment climate is particularly poor.** Foreign investment dropped by over 20 percent in 1986. China's leaders have recognized that foreign companies are being deterred by many regulations and costs over which the Chinese Government has control, as well as by more intractable deficiencies in skilled manpower, infrastructure, and resources. Significant steps have been taken to improve the atmosphere for foreign business (e.g., preferential tax treatment), but it remains to be seen whether these will be adequate.

It should be noted that some U.S. companies are doing quite well in China, particularly those that are not involved in joint ventures or other manufacturing investments. Two-way trade is over $8 billion and is still rising. Some companies recognize that it takes a long time to get established but are convinced that eventually the Chinese market will justify their patience. Others are waiting for other markets to improve, and anything sold to China will help bridge a gap, even if at little or no profit.

U.S. Government agencies are also involved in technology transfer as part of an overall effort to cooperate with China and improve relations. A broad agreement on science and technology cooperation was signed in 1979, and 25 protocols implementing the agreement in specific areas such as telecommunications, agriculture, space, environmental protection, transportation, and student/scholar exchange have been signed. Three more are pending. These contacts have facilitated commercial transactions and improved political contacts.

The presence of 17,000 Chinese students and scholars (half of those sent abroad) in American universities has been one of the most effective forms of technology transfer. Most students are in science or engineering courses. It appears that most students leave with friendly personal ties as well as an education, but it is not yet clear whether this will lead to commercial or political benefits for the United States.

The United States has many advantages in competing for the Chinese market (e.g., a reputation in China for advanced technology, connections through many Chinese-Americans, the popularity of the English language in China) but other countries seem to be doing relatively better in trade. Japan exports twice as much to China, and the nations of Western Europe collectively exceed the U.S. level. There are several reasons for this: American companies historically have been less concerned with exports, which have been very difficult during the last few years because of the high dollar. However, government trade policy is also a direct influence. **U.S. export controls are time-consuming and laborious compared with those of other countries, and appear to be applied more rigidly.** Moreover, Japan and West Germany have extensive foreign aid programs in China that lead to considerable trade. Japan, France, Italy, and others provide extensive official financing for exports. As discussed below, the United States does not necessarily have to emulate these tactics, but changes could be considered to improve the competitiveness of American companies.

ECONOMIC AND POLITICAL IMPLICATIONS

Technology transfer will have profound long-term impacts on China's economic and political future. Some sectors such as consumer electronics will benefit considerably because the industry has a head start or because the technology is more easily assimilated. Past experiences suggest that others will find foreign technology to have little effect because the industry is unprepared. **Dissemination of the management concepts of quality, efficiency, and timeliness may be the most important result of technology transfer.** Improvement in the quality of Chinese products (necessary for them to compete in international markets) may be the first general impact of technology transfer to be visible.

It appears quite probable that China's economic growth will remain high (above 5 percent and possibly over 7 percent). The goal of quadrupling the 1980 output by year 2000 should be attainable, though several factors could interfere. Foreign exchange limitations, energy constraints, and political instability could all hold the growth rate down.

China's exports should also rise rapidly over the next 15 years, but the competition with American products will not be great. The newly industrializing economies, including Korea, Taiwan, Mexico, and Brazil are more likely to feel the competition. Direct competition with either industrialized countries or less developed countries is less likely because the product mix will be different. One exception may be American agricultural exports to Asia, which could be hurt by rising Chinese surpluses. On the whole, however, China's increased role in the international economy should be beneficial for the United States.

Several factors may slow China's export growth: rising protectionism in the developed countries may preclude growth in sectors, such as textiles, where China is strong. Diminishing foreign exchange reserves could limit China's ability to invest in new productive capacity. If the quality of China's products doesn't improve sufficiently, there will be limited markets for them in the West, and China may have to turn to the Soviet bloc for trade and credit, a trend that is already appearing.

Photo credit: McDonnell Douglas Corp.

Construction of an MD-82 twin jet transport at the Shanghai Aircraft Industrial Corp., under a coproduction agreement with McDonnell Douglas Corp. The 25 planes will be certified by the U.S. Federal Aviation Administration.

There is a strong relationship among modernization, economic reforms, political changes, and technology transfer. As long as modernization is a prime goal (as it has been for the last 10 years) most economic reforms made to date will be retained. Modernization depends on technology transfer to achieve more efficient production, and further economic reforms will be needed to assimilate technology. However, the economic reforms are straining the political system, as evidenced by reactions to recent public demonstrations. If political reforms do not reinforce economic reforms, modernization is likely to be slow.

Some of the more difficult economic reforms have yet to be implemented. Price decontrol is essential for rational economic decisionmaking, but it strikes at the heart of the concept of the planned economy. Mobility of labor would increase productivity but would bring unaccustomed social dislocations. Recent developments suggest that there is a strong resistance to reforms such as eliminating the control of Communist Party cadres over factory operations. If China insists on making ideology preeminent, it is unlikely to greatly improve its economic efficiency.

The leadership succession to Deng Xiaoping is one of the most crucial questions. Virtually all of China's leaders support economic reform, but there are major differences of opinion over how fast and far it should proceed. Promoting technology transfer benefits the United States by strengthening the hand of reform-minded leaders who have favored opening up to the West, largely to obtain technology.

If China's modernization program turns out to be even a partial failure, there are likely to be negative implications for the United States. A society disappointed and frustrated from unmet expectations of economic improvement would be more susceptible to political extremism, which could easily have ramifications for Taiwan and Korea. China would also be a less valuable trading partner for the West and could move closer to the Soviet bloc which presents fewer demands for hard currency and quality products.

However, successful reforms will create their own problems. Rising expectations of the population and critical environmental problems will make enormous demands on the leadership. Economic and political changes are creating an environment that will encourage a pluralism of ideas and a liberalization that is incompatible with traditional Communist Party control. It remains to be seen whether the party can accommodate itself to these changes and define a new social role, or whether it will attempt to slow modernization to preserve its control. The present problems of the reform movement indicate that the party conservatives still have considerable power, but China's political evolution is likely to exhibit many unpredictable shifts.

STRATEGIC IMPLICATIONS

Technology transfer will assist China's military. The important questions are how much it will help and how much that matters to the United States or its allies. The first question involves China's military needs and internal capabilities, the second involves China's foreign policy.

At present, China's military is large but unsophisticated technologically. It has a great many tanks and planes, some missiles, nuclear warheads, and ships, and even a few nuclear submarines, but all are outdated and much less effective than U.S. or Soviet equivalents. China is not a major power even regionally, as demonstrated by its ineffectual excursion into Vietnam in 1979. China's military capability is improving, especially in the strategic forces needed to deter a Soviet attack and in nontechnical ways such as command structure and professionalism, but the process will be gradual.

China's military can benefit from foreign technology in three ways: it can buy military technology directly, obtain civilian technology that has military applications, or develop its own modern weapons systems as its economy as a whole modernizes.

The United States and other nations have offered to sell military equipment to China, including the avionics package for the F-8 fighter, but there have been few contracts because China apparently cannot afford to buy many weapons systems. **Acquiring modern weapons would be the fastest way to a modernized military, but China does not feel the need to be pressing enough to sacrifice its economic priorities.** Instead, it prefers to import technology rather than equipment, a rationale particularly compelling for the military, which often needs very large quantities of each piece of equipment.

The transfer of dual-use technologies has increased rapidly. While it is reasonable to assume that China's military has access to such technology if it demands it, that does not mean that the military will be able to use it effectively. Until recently, civilian and military enterprises were kept separate, with the military being given priority on resources and talent. Military factories were significantly more sophisticated than civilian ones. This has changed over the past few years. Civilian factories have enjoyed much more technology transfer and appear to be modernizing faster. Both have exhibited considerable difficulty in assimilating new technology. For instance, the United Kingdom transferred the Spey jet fighter engine technology, but the military factory never was able to manufacture it successfully. Examples of successful reverse-engineering are very few. Chinese military factories produce large quantities of unsophisticated weapons that sell well in the Third World, but their production of sophisticated systems is very limited.

Modern military systems are complicated and demanding. They must be designed by teams of talented and experienced engineers and scientists representing a variety of disciplines. Their manufacture calls for additional expertise and the availability of precision production equipment and high-quality supplies. **China's difficulty in assimilating advanced technologies suggests that more could be transferred without incurring much risk that China will use them to produce sophisticated weapons systems, but this risk will grow over the years as China's technological capability improves.**

For instance, table 1 shows the major components and technologies involved in antisubmarine warfare (ASW), one of the key mission areas which would significantly enhance China's overall military capability. Critical ASW technologies should not be transferred unless there is an explicit political decision that this would be in the U.S. national interest. Those technologies that are unique to ASW are clearly critical. Others are so readily available for commercial uses that no purpose would be served in trying to contain them. The difficulty comes with the intermediate, dual-use technologies, such as spectrum analyzers, the electronic instruments used to identify the source of noise by analyzing the acoustic patterns.

Spectrum analyzers are sold frequently to China, including sophisticated models that would be useful in ASW (though they would not play a prime role in U.S. ASW). However, this technology would be extremely difficult to reverse engineer. Moderate relaxation of controls over exports of spectrum analyzers would give China access to more equipment to upgrade its ASW, but would not in itself seriously effect U.S. security interests. However, any such decision has to be considered in the context of other technologies that are being made more available, China's growing technological capabilities, its political intentions and the impact on U.S. allies.

It is likely that military needs are considered when foreign technology is sought. The Chinese National Defense Science, Technology, and Industry Commission reviews requests to determine priorities, but no pattern of technology targeting is apparent. The civilian technology that China seeks has justifiable commercial uses. Considering China's great need for most technologies, the Soviet practice of targeting militarily significant technologies would seem to be irrelevent. There is little evidence that imported dual-use technology has been a significant factor in China's military modernization.

If China is to become a major power, it will be through developing its own capabilities throughout the economy. Thus, in the long term, technology transfer will have a great military effect if it spurs innovation, modernized thinking, research and development, and economic growth generally. However, China will not have the economic depth to become a superpower for several decades, especially considering the progress the United States and the Soviet Union will also be making.

U.S. policy includes the principle of military cooperation, but within certain limits. Many dual-use technologies have been transferred because any gains to Chinese defensive power

Table 1.—Anti-Submarine Warfare Technology

Anti-submarine warfare (ASW) is the detection, identification, and destruction or disabling of an enemy submarine. ASW can be conducted from any suitable "platform" from the air, sea surface, or from another submarine. The basic functions needed to successfully conduct the ASW mission are the same for each platform:

1. **Detection**: by either acoustic or nonacoustic methods.
2. **Classification**: determination of the type of target.
3. **Localization**: target motion analysis and contact management.
4. **Approach to the Target**: closing in on the submarine to within range of one's own ship or aircraft weapons.
5. **Weapon Deployment (Launch)**: actual attack.
6. **Evasion and Reattack**: performed if necessary.
7. **Related Functions**: tactics such as mine avoidance, mine deployment, and surveillance performed as necessary.

Although the basic required ASW functions listed above are always the same, the complexity and difficulty of each of these elements varies from case to case and from platform to platform.

There is no one ASW technology. These functions require the implementation of many different technologies, and capabilities are required across a broad spectrum of engineering and science. Some technologies are critical in the sense that if their performance is substandard, the whole ASW system is significantly affected. Each increased level of sophistication will have a higher level of success in ASW, but there are many different levels that can be successful. Following are the critical technologies, grouped by commercial availability:

a. *Critical technologies not commercially available (easily controlled):*
   - Propulsion design
   - Low-noise machinery design
   - Sonar dome
   - Transducer design
   - Classification techniques/algorithms
   - Acoustic correlation algorithms
   - Contact motion analysis
   - Tracker design algorithms
   - Passive ranging techniques
   - Weapon guidance
   - High-density power-pack design
   - Small-size high-power train design
   - Exotic fuel design
   - Power engineering
   - Multipath processing techniques

b. *Critical technologies with less sophisticated versions available commercially (control is complex):*
   - Low-speed turbines
   - Bearing design
   - Baffle design
   - Beamformer techniques
   - Local area network design
   - Spectrum analyzer design
   - Microelectronic design
   - Beamformer design
   - High-speed graphic techniques
   - Color/bit plane graphics
   - Shape charge techniques
   - Fusing design
   - Magnetic anomaly detection

c. *Critical technologies readily available commercially (controls futile):*
   - Corrosion resistance
   - Ceramic design
   - Elastomer technology
   - Machinery isolation
   - Spectral analysis algorithms
   - Acoustic performance prediction techniques
   - Environmental sampling techniques
   - High-speed math processor design
   - Minicomputer design
   - High-explosive technology

SOURCE: Adapted from "Assessment of ASW Technology Transfer to the People's Republic of China," contractor report prepared for OTA by Global Associates, Ltd., Alexandria, VA, December 1986.

are likely to be of greater Soviet than U.S. concern. Military cooperation has been seen as a natural part of the growing relationship, but concrete steps toward cooperation have been tentative. U.S. arms sales to China, while increasing, remain well below the level of sales elsewhere in Asia, such as to South Korea and Taiwan.

At worst, the current policy of technology transfer to China entails only moderate direct risk to the United States. China will not have the strategic strength for serious threats for several decades. While China has a few intercontinental ballistic missiles capable of reaching the United States, it also has compelling reasons not to launch them. However, other U.S. interests could be threatened more easily. **In particular, as a regional power, China would be capable of putting great pressure on U.S. allies in East Asia.**

Asia has been a region of relative stability and peace since the end of the Vietnam war, with the exception of the Kampuchean problem. There are, however, tensions and several potential flashpoints, specifically Korea and Taiwan. Military outbreaks could become of global significance, especially considering the U.S. and Soviet interests in the area. **The large-**

scale Soviet military buildup and political initiatives are the greatest concerns to the United States. China shares this perception, which has become the basis for de facto military cooperation, though China is very unlikely to jeopardize its status as self-appointed Third World spokesman by an overt alignment.

Some of China's neighbors, however, may see China as a potential threat. Asian attitudes toward China are complex and vary from country to country. All share China's desire to see a Vietnamese withdrawal from Kampuchea and are relieved to see China focusing on economic growth rather than exporting revolution. However, there are misgivings about the effects of U.S. technology transfer on China's economic competitiveness and concern about China's growing influence. Many Asian countries have large Chinese populations, compounding the uneasiness. Such feelings may be inevitable, considering China's size, but special sensitivity by the United States may help minimize future problems. For instance, consultations with these countries on U.S. relations with China may provide reassurances of U.S. intentions.

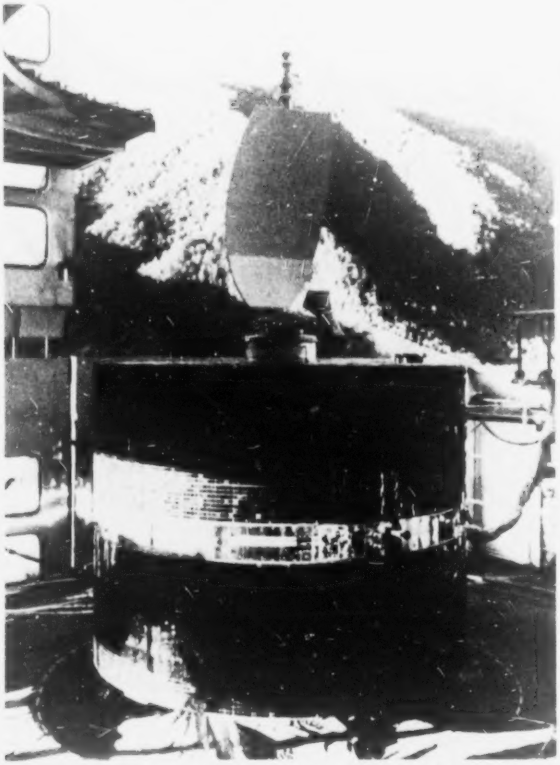

Photo credit: Xinhua News Agency

A Chinese-developed communications satellite, which was launched into geosynchronous orbit in February 1986 on the Long March 3 rocket. China's satellite technology is progressing rapidly, but it is still well behind that of the United States or Europe.

U.S. POLICY CHOICES

U.S. policy currently supports the transfer of technology to China, but within certain limits set by national security considerations. The fundamental rationale for this policy, supported by four U.S. administrations, is that assisting China in its modernization will serve U.S. interests. This general framework represents a compromise between optimism and caution, and permits a flexible approach to specific policy choices. For example, advanced dual-use technologies and arms can be exported on a case-by-case basis, depending on the nature of the technology, the Chinese recipient, the conditions of the sale, and other factors.

The flexible approach has permitted the relaxation of controls as relations have improved and has brought significant benefits to the United States. However, case-by-case export controls are complex to administer (delays in export licensing are often the result) and can yield inconsistent decisions.

U.S. policy also includes some promotional programs to foster exports of nonsensitive equipment and technologies, but these programs are much less extensive than those of Japan, France, and other countries. There is no U.S. aid program and government financing of exports is quite limited relative to other countries.

There is a broad consensus that overall policy is on the right track, but changes in emphasis could be considered to improve the benefits for the United States. One alternative theme would emphasize a more activist strategy of technological cooperation: explicitly using technology transfer to improve relations and trade. Another possibility would be to make better use of technology transfer as a bargaining chip in U.S.-China relations. A third would be to emphasize the multilateral aspects of export control and trade with China.

It would of course be possible to pull back and further restrict technology transfer. However, in the current climate of improved U.S.-China relations, such an approach would appear to be counterproductive. It would alienate China without denying it access to advanced technology, given the availability from many other suppliers. If the worst fears are realized, and China does revert to hostility, the present system can adapt to the change.

Regardless of whether or not a more explicit strategy is developed, a number of specific issues will be addressed by Congress. Most attention has been focused on export controls. For advanced exports with military significance, the United States maintains a system of extensive reviews to ensure that U.S. national security is preserved. The Department of Commerce (DOC) is the lead agency, but the Departments of State and Defense also participate. Multilateral review through COCOM[1] is also required on many such exports.

U.S. industry has been critical of China export controls, protesting lengthy reviews and contracts lost to firms from other countries as a result of more stringent U.S. controls.[2] OTA's research confirmed that other countries are generally able to reach a decision on even sophisticated dual-use exports in a few weeks, while the United States frequently requires months or even years. In addition, only the United States unilaterally imposes controls on items not on the list of COCOM controlled items, and requires that exports to allied countries, if re-exported to third countries, be again subject to the original licensing. The latter requirement has also caused considerable discord between the United States and other COCOM members.

It is difficult to quantify sales lost due to export controls, because so many factors affect the competitiveness of U.S. firms in the China market. The green zone (items likely to be approved for export) has been expanded to cover items in 30 categories on the Commodity Control List. **Today, U.S. controls on exports to China affect primarily a few key advanced technology sectors such as computers, telecommunications, precision instruments, and advanced manufacturing equipment—areas where the United States might otherwise have a significant competitive advantage.** In 1986, computing equipment alone made up almost 80 percent of the value of export licenses approved. Thus, while U.S. controls are not the critical factor determining the overall volume of trade with China, delays can considerably affect the advanced technology exports that China wants.

In recent months there have been signs of improved efficiency in license review. Average processing time for China cases has declined to 57 days in April 1987. However, referred China cases (those reviewed by agencies in addition to DOC) continues to take almost 6 months on average including COCOM review. OTA found that 134 China cases valued at $145 million had been in the system for more than 1 year as of January 1987. Figures 1 and 2 show the trends in processing time for re-

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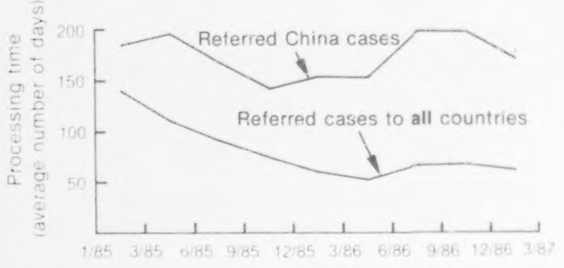
[1] The Coordinating Committee for Multilateral Export Controls, an informal organization of the NATO countries plus Japan, which seeks to harmonize export controls.

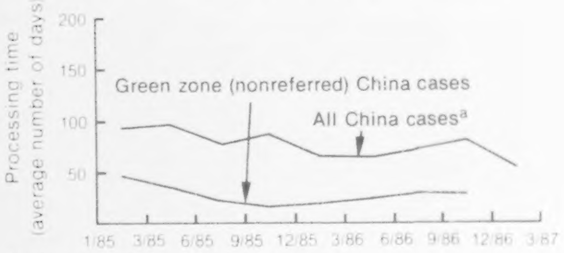
[2] OTA's analysis focuses on controls on exports to China. A recent study by the National Academy of Sciences examines the impact of U.S. national security export controls as they affect global competition: *Balancing The National Interest: U.S National Security Export Controls and Global Economic Competition* (Washington, DC: National Academy Press, 1987).

Figure 1.—Processing Time for Referred (Closed Out) Cases



SOURCE: Office of Technology Assessment, 1987.

Figure 2.—Average Processing Times: China Nonreferred and All China Cases



[a]Average for (referred and nonreferred) all China cases.

SOURCE: Office of Technology Assessment, 1987.

ferred and nonreferred cases. China cases comprise about one-third of the total for all countries pending over statutory limits in 1986.[3]

There are several steps the U.S. Government could take to clarify export control guidelines and improve licensing administration. The process of license review could be made more consistent by expanded use of computerized information on precedent-setting cases. **Additional technical analysis could be applied to develop U.S. positions for an expanded green zone and to develop sectoral approaches for technology transfer to China.** At a broader level, improved mechanisms for resolving disputes among executive branch agencies would reduce processing times for referred cases.

If policymakers wish to relax controls, the key question is whether exports of technologies that are now controlled might endanger U.S. or allied security. **For the near term, there are few dual-use technologies that would make a big difference in China's military capability if transferred.** The discussion of ASW and spectrum analyzers above illustrate how many technologies must be mastered and coordinated to produce usable, sophisticated military systems.

Supercomputers are one of the exceptions. Decisions about such a transfer must take into account a broad array of factors. A supercomputer is useful in a number of defense applications, such as satellite imaging, acoustical intelligence, and nuclear weapons design. China has indigenously developed a supercomputer. It appears to be significantly less capable than the Cray-2 or Cyber 205, but it indicates that China has the expertise to make use of advanced computer technology. However, if an American supercomputer were exported, the Chinese would also need sophisticated software. Programs to simulate weapons design, for example, would not be transferred. Chinese scientists could produce usable software, but they would probably be unable to produce such sophisticated software as that used in advanced U.S. weapons design. An American (or Japanese) supercomputer would eventually be a significant asset for China for improving its own technology and for solving problems, say, in missile accuracy. If China is allowed to buy a supercomputer (perhaps for weather forecasting as authorized for India), conditions could be applied, such as limiting access to the facility or maintaining some U.S. control to prevent uses detrimental to U.S. interests.

Following the COCOM member country agreement to a liberalization of controls on specific types of exports to China, the number of U.S.-China cases submitted to COCOM declined from 287 in January 1986 to 187 in April 1987. However, the approaches to export controls differ among the COCOM countries, and there is leeway for different interpretations of the China regulations within the discretion permitted COCOM members. **OTA's research indicated a need for further harmonization of COCOM country policies.**

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[3] Congress has established deadlines for license processing in the Export Administration Act.

OTA found widespread misunderstanding among businessmen in the United States and abroad about multilateral controls. There is a tendency for all to suspect their competitors of circumventing the rules, but **OTA found little hard evidence to support claims that foreign (COCOM) country governments are doing so.**

A major issue for the future will be whether to remove China exports from COCOM consideration. This would announce full acceptance of China as a Western trading partner, although the commercial implications for U.S. firms are uncertain. If China's current trends continue, this issue will be given serious consideration. However, COCOM members will be cautious because once review is ended, it would be awkward to reinstitute if China's policies later change.

Some exporters have complained that their dual-use technologies are subjected to more stringent controls and take longer to gain approval than military technologies. Sophisticated, state-of-the-art systems such as the F-8 avionics package embody some technology that will be useful to China even if sold as an end product, with no intentional technology transfer. Since the United States has made a policy decision to help China's military to this degree, dual-use exports should be judged by the same standards.

OTA finds that approvals of military and dual-use technology have not been inconsistent. The actual number of munitions cases reviewed has been much smaller than those reviewed for dual-use exports, and the rate of denial higher. Inconsistency could be a problem in the future unless the two sets of reviewers are more aware of what their counterparts are doing. Information about recent arms sales, for example, could be useful to those involved in review of related types of dual-use cases.

A number of factors suggest that U.S.-China military cooperation will continue to develop slowly. Taiwan is one of those factors. China continues to object to U.S. arms sales to Taiwan, while supporters of Taiwan carefully scrutinize the more limited U.S. sales to China. Continued differences over Taiwan may limit U.S.-China military cooperation in practice.

The United States has several promotional programs that support trade with and technology transfer to China, although these programs are not extensive nor coordinated into a comprehensive strategy as are those of Japan, for example. These protocols for science and technology cooperation help set the stage for expanding commercial interaction. The Foreign Commercial Service in the Department of Commerce provides information and assistance to U.S. businesses and helps potential buyers learn of U.S. goods and services. The Dalian Management Center, a training program for Chinese managers, is supported by DOC. The U.S. Government also tries to provide a favorable environment for trade and technology transfer through U.S. official discussions.

U.S. financing programs, including those of the Export-Import Bank, have been comparatively limited and have been guided by the general principle that the private sector should finance exports unless the project is of great national interest or unless a competing foreign bidder is assisted by a national government with subsidized loans. The Overseas Private Investment Corporation (OPIC) has insured more than 20 U.S. investments in China against political risk. Programs of both the Export-Import Bank and OPIC are, however, being scaled back in some areas because of budgetary constraints.

The Trade and Development Program (TDP) has been well received in China. TDP provides project planning services, including feasibility studies. These relatively modest investments can yield significant results. In 1982, for example, a $440,000 TDP feasibility study of a hydropower project led to $20 million in U.S. exports.

Since the United States has no formal aid program to China and because of opposition by some to the use of "mixed credits," which combine official credits and concessional financing, low-cost programs such as those of TDP provide an important tool for U.S. Government support at important early stages of projects.

China is a good test case for U.S. exports, and the U.S. Government could provide more support. U.S. exports to China were lower in 1986 than in 1980. Increases in exports of machinery and equipment were more than offset by decreases in agricultural products. Congressional debates focus on whether the United States can maintain a policy directed at promoting free trade or whether protectionist responses will be forthcoming. Still another possibility would be to develop special bilateral understandings with China. U.S. policies affecting trade and technology transfer to China, however, must be part of an overall U.S. trade policy strategy to be effective over the long term. Technology transfer is a long-term relationship, and the participants could benefit from clear and consistent signals about the direction of government policies.

Specific actions on export control that Congress could consider include the following:

1. improve the efficiency of export control administration:
   - —require Operating Committee reports to Congress on greatly delayed cases;
   - —require more timely information on case status and types of exports approved;
   - —support automated systems to improve the efficiency of review; and
   - —set goals for faster licensing (e.g., 6 days for green-zone cases).
2. modify existing export control policy:
   - —give DOC authority to approve licenses unless *formally* appealed to the President, with automatic approval if cases back up for too long;
   - —require clearer guidelines for prohibited dual-use exports;
   - —require the development of plans for an enlarged green zone;
   - —improve information exchange between munitions and dual-use reviewers; and
   - —establish a distribution license procedure.
3. ensure that U.S. controls are in line with COCOM allies, even if that means dropping unilateral controls.

Potential congressional actions on trade promotion include the following:

1. expand existing programs, including TDP, the Foreign Commercial Service, and official financing;
2. modify existing policy to:
   - —encourage the development of sectoral trade strategies,
   - —review the science and technology protocols and revise government support as appropriate; and
3. initiate an official development assistance program for China.

Technology will continue to be a key element in the expanding U.S.-China relationship, yet one not easily manipulated by governments. Technology transfer can help create a constructive, long-term partnership, but it can also create new and, in some cases, unanticipated problems. Policies aimed narrowly at either the control or promotion of technology transfer to China without consideration of the larger context of U.S.-China relations and Asian security could prove counterproductive.

Chapter 2

The Chinese Context for Technology Transfer: The Economic Issues

Photo credit: Eric Basques

Shanghai-looking down at the Wusong River which leads into the all important Huangpu River. Shanghai, which means "up from the sea" is presently China's busiest port with about half of all Chinese exports passing through this important trading and commercial center.

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Chapter 2

The Chinese Context for Technology Transfer: The Economic Issues

China's economic performance since 1949 has been characterized by both notable achievements and serious failures. The China of 1949 was impoverished and in economic disarray after years of foreign invasion and civil war. Building an industrial economy with the full spectrum of industries and achieving an average growth rate of 6 percent for 30 years were major accomplishments. In addition, China raised the average life expectancy from 36 to 67 years and feeds 22 percent of the world's population with 7 percent of the world's arable land. However, major setbacks from economic mismanagement have also been experienced. China's future economic growth will depend at least as much on avoiding these problems as on achieving great successes.

Scientific knowledge and technical know-how are key elements in China's efforts to modernize its economy and enhance national security. Technology played a role from the 1950s through the 1970s in the development of a comprehensive (albeit, not technically progressive) industrial economy and an extensive research and development (R&D) system. By the late 1970s, however, the Chinese were prepared to acknowledge that many problems with their industrial and R&D systems were inhibiting the further development of the nation's technical capabilities.

Important changes in policies were begun in the late 1970s, including the pursuit of modern technology from abroad. Since then, many Chinese policymakers have come to realize that the development of technical capabilities faces *systemic* problems that cannot be solved simply by changing the R&D apparatus or by importing more foreign technology. Rather, changes on a number of different fronts are required.

More recent policy changes have included major reforms in the economy. China's relationships with the international environment have changed dramatically with the initiation of the open door (*kai fang*) policy and the efforts it entails to attract technology and investment from abroad. Operational objectives for technical capabilities have been redefined, and a number of other measures for altering the policy and managerial environment have been taken.

Together, these initiatives, and the problems they are intended to address, constitute the Chinese context for technology transfer. In this and the following chapter, the elements of China's quest for enhanced technical capability are examined and analyzed.

THE CULTURAL REVOLUTION'S LEGACY

All Chinese leaders since the turn of the century, Communist or non-Communist, have shared a desire to make China a strong world power. However, the means to this goal have changed radically. Since the end of the Cultural Revolution (1966-76), Chinese leaders have introduced major modifications to the political and economic institutions that evolved during the Maoist era (1949-76) of "socialist construction." After decades of relative isolation from the capitalist world, China now seeks to participate in the international economy, to invite capitalist participation in Chinese modernization programs, and to secure access to the technology of capitalist countries, all while retaining its basic socialist character. These near-revolutionary changes in policy have been implemented despite formidable obstacles, most of which were created or exacerbated by the Cultural Revolution. In particular, the new leadership had to deal with widespread political disillusionment and remove from office thousands of cadres who had risen to positions of influence during the Cultural Revolution.

As economic growth and technological progress again became high priorities, the post-Cultural Revolution leaders have had to confront long-standing problems. In particular, economic productivity was low and the rate of growth declining. According to one report:

> . . . national income produced per 100 yuan of fixed assets averaged 34 yuan during the 1976-79 period, compared with 52 yuan during the First Five Year Plan. Over one-third of all state-owned enterprises were running at a loss in 1976. In 1978, 43 percent of the quality and 55 percent of the consumption norms in industry could not meet the best levels set in the 1960s.[1]

Rates of productivity increases declined dramatically after 1965 and began to rise again only in the 1980s.[2] The causes of this decline are complicated. They include a poor incentive system for labor and management, rigid economic planning, and serious problems in fostering technological innovation. To some extent, these factors are inherent to centrally planned economies, as discussed below. However, the Cultural Revolution not only disrupted progress that might have been made in that decade, it also induced in many educated Chinese (those best equipped to solve the problems) an enduring fear of standing out by being too successful.

Declining gains in productivity were not attributable to a lack of investment. In fact, between 1949 and 1979 the average annual rate of investment was 11.4 percent, which was largely directed into capital construction in the heavy industry sector, with the metallurgical, energy, and machine building industries receiving about 65 percent of industry's share.[3] However, the 6 percent average annual growth of the economy was not commensurate with these investments. Clearly, the Chinese had not gained the productivity benefits from investment that other countries realized. Returns on investment were one-third of those in Japan and labor productivity was one-tenth. Energy consumption per unit of output was as much as five times greater than that in the advanced countries, and while machinery exports made up from 40 to 60 percent of the total exports of the latter, they were only about 5 percent of Chinese exports.[4]

Thus, Chinese economic growth has been due largely to very high rates of investment in fixed capital over the years rather than productivity improvements. Consumption and per capita income remained low. There were, in short, imperatives for taking an approach that would result in more efficient use of inputs and progressive technological change.[5]

Another legacy of the Cultural Revolution was the stagnation of the R&D and educational systems. China's research organizations, universities, and science policy and management agencies were terribly disrupted by the Cultural Revolution. Training of new scientists essentially ceased, trained scientists were not properly employed, and the infrastructure for research was neglected. This situation exacerbated the separation of research from production, a problem that had plagued Chinese R&D since it was organized along Soviet lines in the 1950s. Although technological achievements had been made, especially in the national defense sector, the incorporation of new technology into serial production was not widespread, and the strict separation of military-related work from the civilian economy prevented the latter from benefitting from the most advanced technology.

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[1] Elizabeth J. Perry and Christine Wong (eds.), *The Political Economy of Reform in Post-Mao China* (Cambridge, MA: Council on East Asian Studies, Harvard University, 1985), p. 4.

[2] Robert F. Dernberger, "China's Development Strategy: Investment Financing Needs and Sources," paper presented to the Fifteenth Sino-American Conference on Mainland China, Taipei, June 1986.

[3] Ibid.

[4] Sun Zhenhuan, "A Study on the Question of an Integrated Military-Civilian Industrial System," *Jingji Yanjiu* 5, May 20, 1985. In JPRS-CEA-85-080 Sept. 3, 1985, pp. 2-3.

[5] For a more complete analysis of these productivity problems, See Gene Tidrick, *Productivity Growth and Technological Change in Chinese Industry*, World Bank Staff Working Papers, No. 761 (Washington, DC: The World Bank, 1986).

Moreover, as Chinese scientists traveled abroad more widely in the early 1970s, they began to realize how much further they had fallen behind during the Cultural Revolution, a very dynamic period for world science. China's leaders found that they could not look to the archaic R&D system to be the source for new technology needed by Chinese industry or even the knowledge base for the effective assimilation of imported technology.[6]

Other factors also contributed to China's readiness to experiment. Deng Xiaoping, who emerged as China's senior leader, clearly wished to see progress toward the achievement of the goals of the four modernizations policy (with which he had been closely associated since 1975) in his lifetime. Second, China's political leaders could not ignore the successful economic performance of the Asian newly industrialized countries (NICs) in the 1970s. Third, the relative peace in Asia-combined with the evolving new relationship with the United States- offered China the opportunity to rethink its domestic economic structure. In particular, it offered the possibility to move away from the Maoist idea of organizing the economy according to regional self-sufficiency, a strategy dictated by national defense considerations and perceptions of a threatening Asian regional environment. Instead, new forms of economic integration, which presumably would be more economically rational, were possible.[7]

China in the late 1970s was thus experiencing a convergence of forces for major redirections of policy. In this context China began experimenting with extensive reforms in the economy, and the major opening to the outside world that has become known as the open door policy. This opening was based on the assumption that China's modernization could not be realized without such interactions, an assumption that differs markedly from Maoist self-reliance.

The combination of domestic reform and the open door policy has profound impacts on technology transfer to China. The open door has entailed the invitation of foreign economic participation in Chinese development, and has led both to a major expansion of the amount and variety of technology going to China and to an increase in the variety of modes of transfer. It has also allowed more than 35,000 students and scholars, mainly in technical fields, to travel abroad.[8] Because the reform program makes it more likely that in the long run the technology being imported will be effectively utilized, the open door policy and economic reform reinforce each other.

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[6] See Richard P. Suttmeier, "Overview: Science and Technology Under Reform," in U.S. Congress, Joint Economic Commission, *China's Economy Looks Toward the Year 2000*, vol. 2 (Washington, DC: U.S. Government Printing Office, 1986), pp. 199-215.

[7] Perry and Wong, op. cit., pp. 4-5.

[8] For an analysis of China's educational relationship with the United States, see Committee for Scholarly Communications with the People's Republic of China, *A Relationship Restored: Trends in U.S.-China Educational Exchanges, 1978-1984* (Washington, DC: The National Academy Press, 1986).

THE CHINESE ECONOMY

Economic Structure

The old development strategy left the economy unbalanced. China is a low-income country with a very large agricultural sector of low productivity. Its industrial output per worker is that of a middle-income country, largely because of massive investments in heavy industry, but this sector is still small compared with agriculture. The greatest anomaly, however, is the service sector, which is relatively smaller than that of almost any other country.[9]

As Chinese leaders implemented their new policies, they found that inadequacies in economic performance were traceable to fundamental problems with the economic structure as well as to the disruptions caused by the Cultural Revolution. In the 1950s, the Chinese economy was modeled on that of the Soviet Union, and many of the features of a centrally planned economy (CPE) are still prominent. Three defining characteristics of such an economy are that most of the means of production (especially in industry) are owned either by the state or by collectives, that the allocation of resources is accomplished mainly by the decisions of central planners, and that prices therefore have a secondary role in resource allocation.[10]

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[9] The World Bank, *China: Long-Term Issues and Options* (Washington, DC: 1985).

These characteristics, as in other CPEs, became translated into characteristic economic organizations of the state. Central planning bodies (in China, the State Planning and Economic Commissions) in principle oversee a large number of specialized government ministries such as the Ministries of Machine Building, Electronics, Astronautics, and Railways, discussed later in this report, with responsibilities for operating the economy. Under the ministries are the enterprises, factories, and transport and commercial organs that are the loci of the economic activity. To function effectively, central planners must have abundant and accurate information, the capacity to process the information, and the confidence that their decisions will be implemented without distortions. However, neither China nor any other CPE has met these conditions. In practice, China's CPE does not run as the formal design would suggest.[11]

China began experimenting with the operation of a CPE in the late 1950s mainly by decentralizing decisionmaking to units of local government and taking a more collective approach to factory management.[12] These changes also led to a more active role in economic management for local Communist Party committees.

Policies followed during the Cultural Revolution cemented a significant role for local authorities in the operation of much of the economy.[13] Thus, while many Chinese enterprises are under the supervision of the central government, many others are under units of local government. In some industries, strong competition has developed between local and central control. Shanghai's competition with the Ministry of Electronics over leadership in computers and microelectronics is a prime example.[14]

The legacy of experiments with decentralization and recentralization has had profound effects on the structure of and distribution of influence within the Chinese economy. A large component of the economy outside the state plan is controlled by local authorities who have access to their own investment funds.[15] This nonplan sector includes collective enterprises and village industry. In recent years it has grown more rapidly than the planned sector and has come to represent between one-fourth and one-third of the value of industrial output.

Even that part of the economy more clearly under the control of the central government fails to meet the ideals of central planning. In particular, the production ministries have, over the years, accumulated powers over the control of substantial material and human resources (outside the national budget) that make direction and coordination by central planning bodies difficult. The entrenched power of the ministries and the access to substantial resources (which are outside the national budget) enjoyed by local authorities make the goal of coordinated central planning and plan implementation quite difficult.

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[10] Cf. Robert F. Dernberger, "Economic Policy and Performance," *in* U.S. Congress, Joint Economic Committee, *China's Economy Looks Toward the Year 2000* (Washington, DC: U.S. Government Printing Office, 1986), pp. 21 ff.

[11] Cf., Ed A. Hewett, "Reflections on a December, 1984 Trip to the PRC," *in* Janet A. Cady (ed.), *Economic Reform in China*, Report of the American Economists Study Team to the People's Republic of China (New York, NY: National Committee on U.S.-China Relations, n.d.) pp. 33-39.

[12] A perennial issue in Chinese decentralization has been whether to decentralize to the factory or enterprise level (the intent of the current reforms) or to the level of local government.

[13] Christine P.W. Wong, "Ownership and Control in Chinese Industry: The Maoist Legacy and Prospects for the 1980s," *China's Economy Looks Toward the Year 2000*, vol. 1, pp. 571-604.

[14] Denis Fred Simon, "China's Evolving Computer Industry: The Role of Foreign Technology Transfers," app. 2 in vol. II of this report, May 1986.

[15] Barry Naughton, "The Decline of Central Control Over Investment in Post-Mao China," *in* M.D. Lampton (ed.), *Policy Implementation in Post-Mao China* (Berkley, CA: University of California Press, forthcoming). See also, Wong, op. cit.

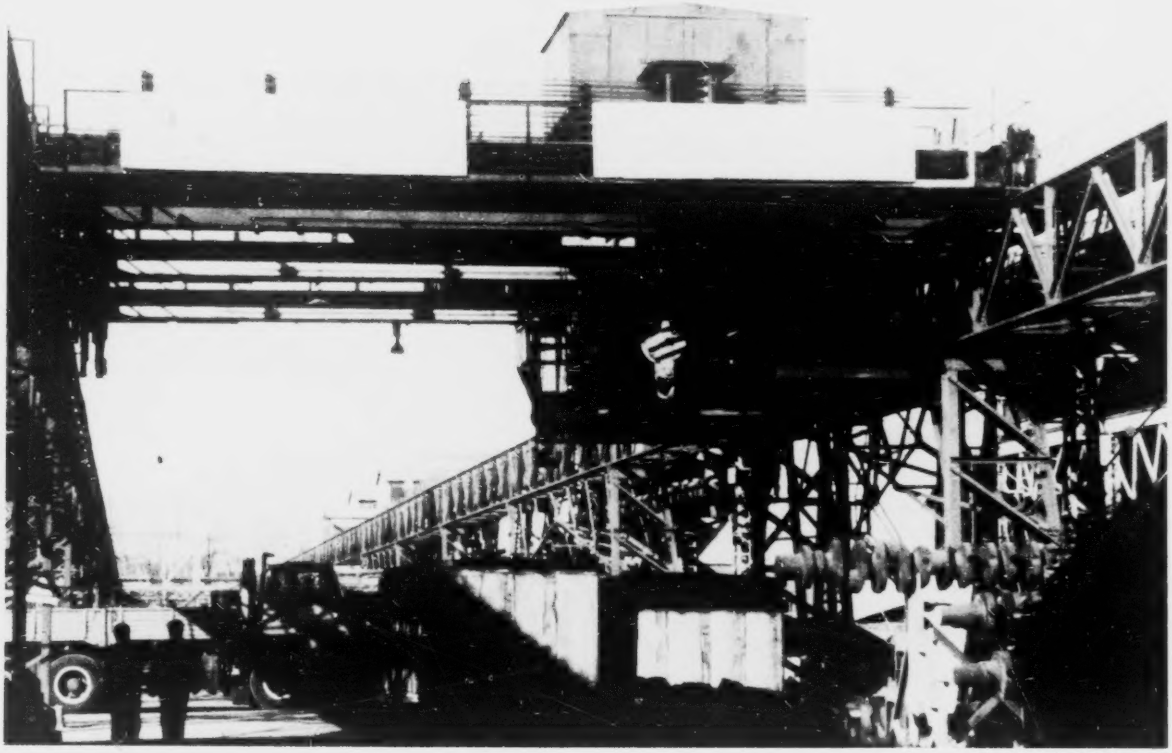

Photo credit: Eric Basques

One of the many storage yards at the Dalian diesel locomotive factory—note the diesel engine crankshafts at the lower right. The Dalian plant produces the Dongfeng locomotive, regarded as China's best.

It is therefore useful to think of the structure of the economy in political terms, with tensions existing between central planners and the ministries and between central and local authorities. Although it would be a mistake to underestimate the ultimate powers of the central planning authorities, there have clearly been much less effective central direction, control, and coordination in the routine operation of economic institutions than had been assumed. The Chinese bureaucratic morass and the delays in decisionmaking that inform the tales of frustration told by foreign business representatives must be seen in light of this institutional setting.

Other effects of the economy during the Maoist period are also still being felt. The tradition of collectivism in factory management, for instance, has tended to place the immediate interests of the workers ahead of economic efficiency. The Chinese enterprise has thus been not only an economic unit, but also a unit of government and a welfare institution. Not surprisingly, the emergence of modern enterprise management has been slowed, with the result that managerial deficiencies are now a major obstacle to the realization of economic objectives.[16]

The case for new directions in economic policy and changes in economic institutions, therefore, has been seen by Chinese leaders as a compelling one. These changes, called a new "development strategy," include new sectoral priorities, new sources of growth, and changes in economic institutions and behavioral rules that are part of the reform program.[17]

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[16] William A. Fischer, "The Transfer of Western Managerial Knowledge to China," app. 5 in vol. II of this report, May 1986.

Economic Reforms

The reform of China's industrial economy has its official expression in the "Decision on the Reform of the Urban Economy" announced at the Third Plenum of the Twelfth Party Congress in October 1984. However, the current reform experience in Chinese industry has its origins in reform experiments begun following the Third Plenary Session of the Eleventh Party Congress in December 1978. In addition, reforms in agriculture preceded the current industrial reforms and have enjoyed much success and popular support.

The intent of the economic reform efforts is to make workers, managers, and enterprises more accountable for their work and to increase the quality of economic decisionmaking. Accordingly, the reform measures adopted have been aimed at the incentive structures at work and at altering the loci of decisionmaking. The key elements include:

1. Increasing the autonomy of enterprises for making decisions about what to produce and how to produce it.
2. Allowing enterprises to retain more of their earnings, which can be used for investment, for bonuses, and for improving living and working conditions for workers.
3. Allowing enterprises to buy more of what they need and sell more of what they produce in marketplaces instead of through state-administered commercial channels. The role of central planning will thus be changed, with some sectors of the economy removed from the planning system and the substitution of "guidance plans" for mandatory plans.
4. Making enterprises responsible for meeting obligations to the state through the payment of taxes instead of measuring their performance and collecting their remissions to the state through shares of profits.
5. Reforming prices gradually to reflect scarcity values.
6. Reforming the banking system to make it more of an instrument for macroeconomic control; the financing of enterprise activities is to be done through banks rather than through state appropriation.
7. Reducing the role of party committees in economic management.

Although official reports from China on the reforms are quite positive, and reflect a commitment by the leadership to continue its course, the implementation of reforms in industry has clearly been more difficult than in agriculture. For instance, it is more difficult to provide incentives for greater individual effort in industry, and there are many more sources of opposition to reform.

Without a rational price system, the efforts to give enterprises more autonomy have led to macroeconomic (as well as microeconomic) distortions that have troubled the central government, which recognizes the importance of price reform but also understands that the transition from administered prices to market prices is fraught with political dangers. Student demonstrations in late 1985, ostensibly directed at Japanese trading practices, were also a reflection of the discontent felt by many urban residents with the increases in living costs occasioned by price reform. The regime therefore approaches the pace of price reform with some caution, anticipating at least a 5-year period of price reform implementaion.

According to one recent analysis, the most dramatic changes in China have occurred outside of the formally planned economy. This sector outside the plan has always existed in China, but the reforms have encouraged its vigor and enlargement.[18] Reportedly, growth in the rural industry sector in 1984 was 40 percent, climbing to more than 50 percent (if annualized) during the first half of 1985 (when overall industrial growth was more than 23 percent). Indeed, growth at this rate has become very troublesome for central policymakers because it has led to distortions in national investment and to the waste of raw materials. Central authorities have therefore attempted to limit the rate of growth.

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[17] Dernberger, "China's Development Strategy," op. cit.

[18] Barry Naughton, "Summary of Findings," *in* Cady, op. cit.

Reforms have had much less success within the planned sector, particularly with regard to price reform. Overall, Chinese reform must be seen as involving these two sectors, with the outside-the-plan economy realizing many of the benefits of liberalization and putting pressure on the within-the-plan economy to change. A crucial issue is how China manages the transitional period. It must keep pressure on the within-plan sector to change, but until then, there will be both increasing imbalances in the supplies of energy and raw materials going to the two sectors and uneven changes in wages and the supply of consumer goods, with the danger of serious inflation. Such dangers invite the reassertion of central controls that, if done clumsily, could vitiate the reforms.

It should be reiterated that the efficacy of comprehensive central financial controls always remains in doubt. Abundant resources remain in the hands of local authorities, giving them the power to pursue investment strategies that may not be in China's best overall interests. These "extra-budgetary funds" have over the years, made possible a close, but not necessarily economically rational, relationship between local governments and the enterprises under their jurisdictions. Such relationships frustrate not only the center's desires for greater macro-economic coordination, but also the objectives of central reformers for greater enterprise autonomy. Viewed in this way, the reforms can be understood to be *both* centralizing (to achieve more effective central control) and decentralizing (to provide for greater enterprise autonomy and to free the economy of political interventions from local governments).

Thus, the experience of the Sixth Plan period indicates three things about the Chinese economy. First, there is enormous energy residing in the economy that can be released with the right incentives, but this energy is more readily apparent in the outside-the-plan part of the economy. Second, there are very large amounts of financial resources in the economy available to local governments and relatively uncontrollable by the central authorities. Local levels have a strong inclination to use these resources to grow extensively. Thus, even though the central authorities have been able to curb investment financed from the state budget, the level of total investment in the economy in 1984 was 42 percent higher than in 1979, owing largely to investments made by local authorities with extra-budgetary funds.[19]

Third, the experience of the Sixth Plan period shows the need for strong central controls of the economy. Given the institutional features of the Chinese economy, its underdeveloped market mechanisms, traditions of decentralization, and irrational price system, rational economic behavior at the micro level can be and often is irrational at the macro level. This is particularly true given the shortages of energy, raw materials, transport, and communications infrastructure.

During 1986 the leadership backed away from vigorous implementation of the reform package. The retrenchment was undertaken to consolidate the reforms to date and to adjust to the economic problems of 1985—the overheating of the economy, difficulties in foreign trade occasioned by the rapid drawing down of foreign exchange reserves, and the drop in world oil prices, which exacerbated the foreign exchange problem.

These unexpected economic difficulties made the politics of reform more complicated, strengthened the voices of the more conservative members of the leadership who call for a more cautious approach to reform, and pointed to the possibility that the more difficult challenges of reform have yet to be faced. Carrying the reforms further for instance, through loosening controls over labor and capital will be necessary to solve some of the problems the reforms have encountered. However, further reforms of this sort are also likely to engender more active political opposition, since they cut more closely to the essence of a Marxist-Leninist regime.[20] The conflicts in Beijing in early 1987 appear to be over precisely these issues. Further reform, therefore, becomes a challenge to Chinese politics, and makes the question of the future strength of the reform coalition a matter of importance. This question is further discussed in chapter 6.

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[19] Dernberger, "China's Development Strategy," op. cit.

The Seventh Five-Year Plan

Economic policies initiated in the early 1980s have clearly stimulated economic growth. Indeed, the pace of growth has been such that in 1985 central officials feared that the economy was overheating. The new 5-year plan (the seventh) thus calls for more moderate growth while pushing for the full implementation of the reform program.

As proposed by the Central Committee of the Communist Party in September 1985,[21] and approved by the National People's Congress in April 1986,[22] the plan differs from earlier plans in deemphasizing specific quantitative targets for the economy. Instead, it contains general principles for action and identifies areas for special attention. It is usefully seen as a plan for a transitional period, one that builds on the achievements of, and attempts to compensate for, the weaknesses of the Sixth Plan while looking ahead to the needs of the 1990s.

Thus, the Seventh Plan calls for the continued implementation of reforms throughout the plan period. It calls for continued improvement in living conditions and an increase of 4 to 5 percent in the average annual per capita level of consumption. It is premised on a comprehensive rate of growth in Gross Value of Industrial and Agriculture Output (GVIAO) of 6.7 percent per annum, or an average annual growth in gross national product of 7.5 percent (which includes an average increase of 11.4 percent per year in the service sector). Labor productivity is to grow at an average annual rate of 3.8 percent.[23]

The plan has a number of implications for technology transfer and foreign investment. First, it sets economic priorities that will entail the importation of technology. Major investments are called for in transportation, telecommunications, energy, and semi-finished and raw materials.

The plan also calls for the acceleration of the development of new high-technology industry, especially electronics and computers, and the modernization of large, established industries, such as the automobile industry. The severity of the need for technological transformation of established industry is reflected in one recent report:

> . . . only 20 percent of the industries in China can measure up to standards of developed countries in the past decade. Sixty percent are so obsolete that they need to be replaced or upgraded. This explains the wide gap between China and developed countries in economic efficiency and productivity.
>
> China consumes 210,000 tons of coal per $10,000 in gross national product; the Soviet Union 120,000 tons, the United States 91,000 tons and Japan 37,000 tons . . .[24]

The Chinese have placed great hope in the industrial use of microelectronics technology (for control systems) for the technical transformation of industry. Altogether, there will be 600 major projects for the technological transformation of existing industries. Priority in importing technology will be given to the technologies for infrastructure development, for establishing new industries, and for transformation projects that will contribute to China's ability to earn foreign exchange.

The plan reaffirms the continuation of the open door policy, assumes the continuation of foreign investment, and predicts a 40- to 50-percent increase in foreign trade over the plan period. China expects to increase exports in areas of current strength (textiles, petroleum, coal, nonferrous metals, farm sidelines, and traditional handicrafts) and hopes to increase its activities in the area of finished manufactures (especially machine tools, electrical products, apparel, and processed foods). Exports are predicted to rise slightly more rapidly (8.1 percent) than imports (6.1 percent).

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[20] The dilemmas of incomplete reform, or partial marketization, in socialist systems are explored in Jan S. Prybyla, "Mainland China and Hungary: To Market, To Market . . .," paper presented to the Fifteenth Sino-American Conference on Mainland China, Taipei, June 8-14, 1986.

[21] See "Proposal of the Central Committee of the Chinese Communist Party for the Seventh Five-Year Plan for National Economic and Social Development," *Xinhua* (Beijing: Sept. 25, 1986). In *FBIS*, Sept. 26, 1986, pp. K1-K32.

[22] See "Excerpts From China's Seventh Five-Year Plan (1986-1990)," *Xinhua* (Beijing: Apr. 14, 1986). In *FBIS* (Apr. 18, 1986), pp. K1-K37.

[23] Ibid.

[24] *China Daily*, Oct. 22, 1985.

Clearly discernible in the language of the plan is a sense of the interrelatedness of importing technology and exporting products. Exports are necessary for paying for imports, and China realizes that its export performance in price, quality, and value added will depend on its ability to acquire and assimilate new technologies.

The final area where the Seventh Plan's contents pertain to technology transfer is the stress placed on the development of indigenous scientific and technological capabilities (discussed in ch. 3) and the emphasis on human resource development. The manpower development projections call for the graduation of 2.6 million young people from regular institutions of higher education (as opposed to radio, TV, correspondence, and night schools, which are also to see significant increases) and of some 180,000 from graduate programs during the plan period. These figures represent increases of approximately 70 percent and 400 percent, respectively, over the Sixth Five-Year Plan period. In addition, there is to be a 110-percent increase in the numbers trained in polytechnic and vocational schools over the previous plan period.[25] This ambitious human resources development plan eventually should ease China's shortage of trained personnel, a major obstacle to China's ability to absorb technology and foster domestic innovation.

Economic Challenges

In spite of the promises of the Seventh Plan, China's developmental problems remain formidable. An enduring issue is the lack of innovativeness in the Chinese industrial economy, a problem with clear implications for productivity. The shortage of available energy remains a fundamental constraint on growth. The underdevelopment of transportation and communications is severe.

In 1981 the Chinese announced their intention to quadruple the size of the economy, measured in GVIAO, over the 1980 level by 2000. In addition, they called for raising the national income per capita by approximately 5 percent per year, from $300 in 1980 to $800 by 2000. Two important issues are the sources of growth (extensive, through further heavy investment, versus intensive, through technological change) and the constraints on growth (primarily, limited investment, energy, and transport and communications resources).

In its recent analysis, the World Bank has explored the growth prospects of the Chinese economy for the remainder of the century.[26] While accepting that China may reach its quadrupling goal, the bank study also considered two other scenarios. In the first, constraints on growth from energy, raw materials, and infrastructure shortages and from managerial difficulties hold growth below the quadrupling rate. The second alternative places less emphasis on physical constraints and foresees a major expansion of the service sector. In this scenario, even though the GVIAO quadrupling goal is not quite met, the per capita income goals are reached. The appeal of this balanced scenario is that by bringing the service sector more in line with that of other countries, China can more efficiently create national wealth while requiring fewer of the scarce inputs needed for the quadrupling approach.

Chinese authorities have not publicly altered the quadrupling goal in response to the World Bank analysis. However, they have called for a more active service sector, and the drift of the reform program is supportive of service expansion. At the same time, major efforts will be made to remove the main obstacles to the

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[25] Excerpts from China's Seventh Five-Year Plan.

[26] The World Bank, op. cit.

时间就是金钱·效率就是生命！
TIME IS MONEY. EFFICIENCY IS LIFE

Photo credit: Eric Basques

Slogans promoting increased worker productivity are visible at many Chinese plants. This one can be found at the Beijing Jeep Corp. joint venture plant in Beijing.

quadrupling goal: inefficient management, shortages of materials and infrastructure deficiencies.

China's movement toward the quadrupling goal has so far been impressive. Quadrupling the GVIAO by 2000 will require annual rates of growth of 7 percent. During the Sixth Five-Year Plan period (1980-85), the economy grew at a substantially faster pace (averaging 11 percent per annum between 1981 and 1984). Substantial growth has resulted from reforms in the agricultural sector, not only leading to increases in the value of agricultural output, but also stimulating new activities in sideline and small rural industrial production. The more general relaxation of economic controls has also led to a boom in construction, to growth in other forms of local industry, and to the appearance of new forms of private and collective enterprise.

China also faces the problem of finding the financial resources, particularly foreign exchange, required to accomplish its development goals. Having decided to seek financial assistance from foreign sources, China has in recent years benefitted from loans from the World Bank and foreign governments. In addition, from the late 1970s to 1984, China accumulated a large foreign exchange reserve. As a result of a decentralization of control over foreign exchange, however, reserves were drawn at an alarming rate in 1985, leading to a recentralization of controls and some rethinking of technology transfer strategy (discussed below) in late 1985. Since exports of petroleum have been China's leading foreign exchange earner in recent years, the decline in world oil prices in the first half of 1986 exacerbated the foreign exchange problem and made it one of the more formidable constraints on growth in the short run.

China will address these problems with a continuation of the trend toward new techniques of finance—such as an increasingly intimate relationship with foreign commercial banks and the further encouragement of foreign investment—and a technology acquisition strategy. By the end of 1985, the foreign exchange problem, the search for foreign investment, and the strategy for technology acquisition had become increasingly intertwined.

In the face of the drawdowns on foreign exchange, the allocation of foreign exchange to Chinese organizations and enterprises increasingly became a function of their ability to earn it. This meant that some sectors, such as the petroleum industry, had a greater claim on scarce foreign exchange than did, for instance the electric power industry. This new foreign exchange norm also created problems for Sino-foreign joint ventures, which the Chinese hoped would be an important vehicle for technology transfer. Joint ventures typically must import equipment and components for a period of time after they start up, and may not be in a position to earn foreign exchange through exports for quite some time. The operations of these enterprises can easily be seriously disrupted if they are denied access to the foreign exchange they expect. The increasing number of such occurrences in early 1986 led foreign firms to question the attractiveness of investments in China.

China's formidable economic problems would be extraordinarily difficult to resolve without technology and investment from abroad. The importance of the open door policy, therefore, is not likely to diminish in the short run, and the Chinese seem willing to continue to modify the policy to improve the business climate in China. Whether they are prepared to take these modifications as far as the foreign businesses would like remains to be seen. It is important to consider some of the features of the open door policy, and some of its problems, in greater detail.

THE OPEN DOOR POLICY

China's open door policy and its reform program are mutually reinforcing. The political, economic, and science and technology reforms noted above will help China select and assimilate foreign technology. Yet, the implementation of the reforms is clearly incomplete, and many problems remain with technology transfer.

Since the beginning of the open door policy in 1978, China has initiated a multifaceted strategy to open itself to the outside world. The measures adopted include:

- the establishment of four "special economic zones" in which foreign investment is encouraged;
- plans to make the the Fujian, Yangtze, and Pearl River deltas "economically open" regions;
- the acceptance of foreign investment and loans from international organizations (especially the World Bank), foreign governments, and commercial sources;
- the approval of a variety of forms of foreign participation in the Chinese economy, including joint ventures, cooperative management schemes, wholly owned foreign enterprises, and compensation trade arrangements;
- cooperative schemes with foreign interests in natural resource surveys and exploitation; and
- the gradual modernization of an infrastructure for interacting with the outside world, including changes in the banking system and the creation of new institutions such as the China International Trust & Investment Corp. (CITIC) and the China Coordinating Center for Business Cooperation, under the State Economic Commission.

To create an environment conducive to foreign investment and technology transfer, the Chinese authorities have also attempted to establish an entirely new legal framework for foreign participation in the economy. Laws have been passed pertaining to joint ventures, foreign contracts, company registration, labor management, special economic zones, foreign enterprise taxation, exchange control, offshore petroleum exploration, marine environment protection, trademarks, patents, and, most recently, the activities of wholly owned foreign firms operating in China. Greater autonomy for approving foreign investments has been given to local governments, and restrictions on foreign banking operations have been loosened.[27]

Thus, much has changed in China's interactions with the world economy since 1978. Whereas China's exports represented only 0.75 percent of the world's exports in that year, they had grown to 1.25 percent in 1984, moving China from 32nd position to 16th in value of exports. From the end of 1978 to the end of 1984, China received more than $17 billion in foreign capital (of which $4 billion were direct investments), which represented about 10.5 percent of the total investment in capital construction during the same period. The use of foreign capital is expected to increase during the Seventh Five-Year Plan period, during which China expects to absorb US$30 billion, $5 to $7 billion of which is to be foreign investment.[28]

The open door has also led to a substantial increase in China's acquisition of foreign technology. Although significant questions remain about absorption and about how to measure flows of technology into China, there is little doubt that technology transfer to China has been substantial. Between 1981 and 1985, for instance, China spent approximately $9.6 billion to import full sets of equipment and other advanced technology. This represented a 69-percent increase over the previous 5-year plan period.[29] Between January and June of 1985, 318 technology import contracts were approved by the Ministry of Foreign Economic Relations and Trade, more than double the number from the same period in the previous year. In dollar terms, the first 6 months of 1985 saw contracts worth $2.05 billion, compared to $339 million from the previous year.[30]

Despite these notable changes, reservations by foreign interests about the Chinese business environment have become more numerous and more serious. Frequently mentioned disincentives operating on foreign firms, according to the U.S. Commerce Department, include:

> . . . foreign currency restrictions making the repatriation of profits uncertain, the overvaluation of the Chinese contribution to Sino-foreign enterprises, inflated labor costs, poor labor discipline, high manufacturing costs, unpredictable customs treatment, undependable supplies of local materials, inadequate energy, transportation, and communications, a cumbersome bureaucracy, still unfavorable tax and accounting policies, an irrational pricing structure, uncertain access to a poorly defined domestic market, a marginal return on investment, and difficult expatriate living conditions.[31]

The ongoing economic reforms themselves introduce uncertainties that make planning more difficult for foreign investors now than in 1979, when joint ventures were first authorized. Furthermore, the new laws are often very general and ambiguous, largely untested, and inconsistently administered by bureaucrats who have not prized legality highly in the past. A framework may be in the making, but as yet it is both fragile and incomplete.[32] Foreign investments and technology transfers are less than the Chinese expected. From 1979 to 1985, the Chinese realized only 36.4 percent of the foreign investment pledged, in contrast to 70.8 percent of the foreign loans pledged during the same period.[33]

To improve the investment climate, the Chinese promulgated new investment regulations in October 1986.[34] The regulations grant a privileged position to export oriented and technologically advanced enterprises established with foreign investment, and attempt to eliminate the arbitrariness that has surrounded the supplies of inputs to foreign-invested firms and the labor and rental rates that have been levied. Although the views of the foreign business community were actively solicited in preparing the regulations, some of the important concerns of the foreign investor—especially the questions of access to the Chinese domestic market and the repatriation of profits—have apparently not been alleviated by the issuance of the regulations.

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[27] Teh-pei Yu, "Foreign Capital in Mainland China," paper presented to The Fifteenth Sino-American Conference on Mainland China, Taipei, June 8-14, 1986.

[28] Teh-pei Yu, "Foreign Capital," op. cit., p. 9.

[29] "Foreign Trade Minister Views Trade Situation," *FBIS*, June 10, 1986, p. K8.

[30] *Xinhua*, Aug. 18, 1985. In JPRS-CEA-85-088, Oct. 2, 1985, p. 81.

[31] U.S. Department of Commerce, "People's Republic of China," *Foreign Economic Trends and Their Implications for the United States*, FET 86-85 (Washington, DC: U.S. Government Printing Office, September 1985).

[32] See, for instance, Ellen R. Eliasoph and Jerome Alan Cohen, "China's New Technology Import Regulations," *The China Business Review*, vol. 12, No. 6, November-December 1985, pp. 36-40.

[33] Teh-pei Yu, "Foreign Capital," op. cit., p. 17.

[34] "Provisions of the State Council of the People's Republic of China for the Encouragement of Foreign Investment" (promulgated on Oct. 11, 1986), *China Daily*, Oct. 14, 1986, p. 2.

Thus, from the foreign perspective, there remain reasons to doubt just how open the open door actually is. Import restrictions, bureaucratic red tape, domestic subsidies, and unfavorable tariffs combine to make a formidable protectionist regime. In part, the existence of this regime reflects the legacy of China's past, the consequences of the interactions of a closed economy modeled on the Soviet Union, Maoist principles of self-reliance, and the turbulence of the Cultural Revolution. However, it also reflects underlying contradictions in China's conception of the open door and ambiguous attitudes toward the international economy in general and foreign technology in particular (a subject pursued in greater depth in ch. 3).

These underlying problems have several components and are inseparable from the often irrational operation of domestic institutions.[35] First, there is a basic ambiguity about China's overall development strategy. Is it to be an export promotion or import substitution strategy?[36] Or is it to involve both, as the new investment regulations seem to imply? Chinese development since the founding of the People's Republic of China has clearly not followed the export promotion strategy. The relatively small export sector of the past, the use of foreign technology (and the relatively little import of it after 1960) to support domestic industrial development, and the strong emphasis on self-reliance are all more consistent with an import substitution approach than one that is export driven.

However much China might want to emulate the export promotion approach of the Asian NICs, there are reasons to doubt it will happen soon. China is a large country with a historic internal focus and enormous domestic needs and problems. China's past strategy of self-reliance and regional self-sufficiency led to a dispersion of industrial projects. Poor transportation and communications hinder the access of the products of this inland economy to the international trading centers on the coast. China's politically powerful basic industries, including machinery suppliers, regard the Chinese domestic market as their preserve. While they are not necessarily opposed to some form of new economic internationalism, they have insisted that the definition of the open door be on their terms. Furthermore, most Chinese products lack the quality and design to be competitive on world markets.

Finally, the most favorable era for pursuing an export-oriented development strategy may have passed, at least for the immediate future. China's desire to expand its exports has already caused trade friction, and the projections of future Chinese exports would suggest that these may intensify. Unlike the Asian NICs, which were able to take advantage of especially open markets in an industrialized world enjoying exceptional prosperity, the Chinese interest in an export-led development approach comes when the Western economies are shaky and their domestic markets are increasingly subject to protectionist pressures.

A range of policies pertaining to exchange rates, tariffs, prices for export items, subsidies and export credits, import licenses, and tax advantages are involved in the shift from import substitution to export promotion. The Chinese have begun to implement policies pertaining to most of these areas to accelerate export expansion. However, many of these are likely to cause negative reactions from China's trading partners and will complicate the question of

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[35] Cf., Huang Fangyi, "Analysis and Suggestions on China's Introduction of Foreign Technology and External Trade," op. cit.

[36] See, John B. Sheahan, "Alternative International Economic Strategies and Their Relevance for China." World Bank Staff Working Papers, No. 759, 1986.

Photo credit: Eric Basques

A Jeep Cherokee being assembled at the Beijing Jeep Corp. plant, a joint venture between the American Motors Corp. and the Beijing Automotive works. This modern assembly line serves as a model for efficient production techniques and improved quality control.

China's re-admission to the General Agreement on Tariffs and Trade.

A second major component of the open door dilemma is the uncertain mixture of decentralization and centralization of foreign economic decisionmaking. This is related to, but not synonymous with, the uncertainties about the mixture of market and planning elements, which is one of the uncertainties of the economic reform program. Chinese experience with the open door policy and with decentralizing marketing reforms since the late 1970s has pointed to the danger of a loss of control over macroeconomic policy as a concomitant of reform. On the other hand, the Chinese are also aware of the stifling of economic activity resulting from certain forms of centralization. The saying "giving rise to rigidity as soon as we exercise centralization, and giving rise to disorder as soon as we relax control" captures the sense of this dilemma. Thus, relaxation of central controls over foreign economic activity in the recent past has led to the rapid dissipation of foreign exchange holdings. At times, as discussed in the following chapter, it has also led to irrational, duplicative technology imports.

The problem of policymaking for importing foreign technology has both institutional and conceptual dimensions. Chinese institutions for the conduct of foreign economic relations reflect both the legacy of socialist foreign trade and the results of the decentralizations introduced since the late 1970s. This institutional legacy has locked China into an alternating pattern of either too much centralization or too little central control exercised in the national interest. China has yet to find a formula for institutions that are able to set and enforce a foreign economic policy that both serves basic national interests (e.g., maintaining responsibility for the nation's foreign exchange holdings) and allows for decentralized decisionmaking in the service of economic dynamism.

The institutional problem has a conceptual or intellectual analog. China is, in effect, searching for the intellectual foundations of an industrial policy. Such an intellectual formulation would spell out which sectors of the economy deserve priority for export promotion or for the import of technology. Should priority go to industries with high immediate export potential (e.g., textiles or consumer electronics), to basic industries such as steel or transportation, or to industries (e.g., advanced electronics, robotics, communications) that would allow China to leapfrog over phases of the product cycle (ignoring perhaps comparative advantage) and compete in high value-added goods and services? The problem of an intellectual formulation is also evident in the lack of a decisionmaking strategy for intrasectoral or intraindustry technology transfer.[37]

Such an intellectual formulation would then serve as a conceptual framework for the myriad analyses, feasibility studies, and decisions China must make about how to use its limited resources to extract the maximum benefit from its interactions with the world economy. At present, although the Chinese recognize the need, such a formulation or strategy does not exist.

The following chapter discusses how some of these issues surrounding the open door policy pertain more specifically to the technology transfer phenomenon.

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[37] See Geoffrey Oldham and Alyson Warhurst, *Technology Transfer to the Chinese Offshore Oil Industry*, unpublished report, University of Sussex, Science Policy Research Unit, no date.

Chapter 3

The Chinese Context for Technology Transfer: Strategies and Issues for Technology Imports

Photo credit: Eric Basques

Yu the Mandarin's Garden in Shanghai is characteristic of the architectural style of the Ming and Qing Dynasties. The garden is divided into three parts, each separated by a white brick wall the top of which forms an undulating gray dragon.

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Chapter 3

The Chinese Context for Technology Transfer: Strategies and Issues for Technology Imports

In the post-Mao period, the Chinese leadership has consistently stressed the central role of science and technology for China's modernization. In 1982 Premier Zhao Ziyang said that it would be impossible to reach China's overall economic goals by year 2000 without major contributions from modern science and technology. The challenge for Chinese planners has thus been to develop a workable strategy and consistent plan for scientific and technological development. After some false starts in the late 1970s, a coherent set of objectives began to take shape in the early 1980s.

GOALS FOR TECHNOLOGICAL MODERNIZATION

China has four categories of goals for technology. The first is for Chinese industry to reach at least the present Western level of technology by year 2000. This will require a major effort at revitalizing established industries, including a special, well-funded program of "technological transformation" (*jishu gaizao*), which is being administered by the State Economic Commission (SEC).

The second objective is to ensure that modern technologies are diffused to China's rural areas. The interest here is not only to continue with the technological transformation of agriculture, but also to provide a modern technological foundation for burgeoning rural industry. China expects that the coming decades will see major movements of the labor force out of agriculture and into rural industry and services. A special project, the Spark program, administered by the State Science and Technology Commission, is designed to provide technological inputs into this major shift in the occupational structure.

A third objective is to give priority to the technologies needed to develop the country's infrastructure and natural resource industries. Thus, a wide variety of technologies pertaining to energy, telecommunications, transportation, and resource exploitation are targeted for acquisition and development. This part of the strategy, by necessity, involves the activities of many Chinese agencies.

Finally, the Chinese have identified a number of technologies that they believe will be the basis for new high-technology industries—electronics and computers (including advanced software applications such as CAD/CAM), biotechnology, materials, robotics, lasers, and space and ocean technologies. The Chinese expect these technologies will lead to major industrial advances and have targeted them for special attention in the hope of becoming competitive.

The achievement of these goals will require the modernization of the domestic research and development (R&D) system. But the Chinese also realize this cannot be achieved without the transfer of foreign technology to China. It is important to note, however, that the various goals entail different approaches for acquiring the appropriate technology. Whereas much of the technology desired is in the hands of foreign companies, some of it (e.g., transportation and telecommunication technologies) is in the hands of foreign governments or public corporations. In addition, the Western university is the locus of much of the knowledge needed to launch high-technology or science-based industries. The sending of students and older scientists abroad to a Western university for advanced training, therefore, can be seen as an important channel for technology transfer.[1]

To gain access to these sources of technologies and use them effectively, the Chinese have initiated programs of domestic reform and have made extraordinary changes in their approaches to foreign relations. This chapter examines the Chinese experience with technology transfer more specifically, beginning with an overview of China's past history of technology transfer.

THE EXPERIENCE WITH TECHNOLOGY TRANSFER

Chinese experience with technology transfer in the 1980s is shaped not only by the current technology objectives discussed above and the overall economic modernization objectives examined in the previous chapter, but also by historical experience. Since the late 19th century, the Chinese have realized the importance of modern technology from the West but have been unable to reach an intellectually and culturally congenial relationship with it. As characterized by one foreign trade official, who was trying to dispel these attitudes, Chinese thinking often goes as follows:

> After the Opium War, imperialist powers carved up China. Our political and economic lifelines were controlled by foreigners, our markets were flooded with foreign goods, and our national industry was severely devastated. Such a period of national humiliation is still fresh in our memory. Therefore people always associate imports with the protection of our national industry, and tend to think that the less imported the better.[2]

Also of concern has been the danger of overreliance on foreign help. The saliance of this historic concern was reinforced at the end of the 1950s, when, after the Chinese allowed themselves to become quite dependent on Soviet technology during the 1950s, the Sino-Soviet relationship soured, and Soviet technical assistance was withdrawn.

The scientific and technical infrastructure developed rapidly in the 1950s, but then the Chinese were forced to rely largely on their own efforts for the further industrial development of the country until the opening to the West in the late 1970s. (Some foreign technology, mostly for whole plants and equipment,[3] came from the capitalist countries after the Sino-Soviet split.) Some of the productivity problems noted in chapter 2 resulted from this extreme self-reliance, but another result was the development of indigenous technical capabilities.

From 1950 to 1960, China imported technology from the Soviet Union and Eastern Europe in support of 156 major industrial projects. These were concentrated in such basic industries as metallurgy, machine building, trucks, coal mining, electric power, and petroleum. Some 400 items of technology were introduced, with an approximate value of $2.66 billion. These transfers were indispensable for the timely establishment of new industries and contributed to the rapid economic growth experienced at the time.[4]

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[1] This issue has been explored in Leo A. Orleans, "Chinese Students and Technology Transfer," *Journal of Northeast Asian Studies*, vol. 4, No. 4, winter 1985; and in Richard P. Suttmeier, "Academic Exchange: Values and Expectations in Science and Engineering," unpublished paper presented at the Conference on Sino-American Educational and Cultural Exchange, Honolulu, HI, The East-West Center, Feb. 18-22, 1985.

[2] Wei Yuming, "On Open Door Policy, Trade With Japan," *Xinhua*, Oct. 25, 1985. In FBIS, Oct. 29, 1985, p. A4.

[3] Huang Fangyi, "Analysis and Suggestions on China's Introduction of Foreign Technology and External Trade," *Asian Survey* (forthcoming).

[4] Ibid. Also, Robert F. Dernberger, "Economic Development and Modernization in Contemporary China: The Attempt To Limit Dependence on the Transfer of Modern Industrial Tech-

(continued on next page)

From the withdrawal of Soviet assistance in 1960 to the outbreak of the Cultural Revolution in 1966, the Chinese began relying more on Japan and Western Europe for technology. Some 84 major contracts worth $280 million were signed in this period. Industries targeted were metallurgy, chemicals and chemical fibers, and synthetic textiles.

From the early 1970s to 1978, China signed some 300 contracts for foreign technology, worth $9.9 billion. The emphasis in this period was on complete plants in such industries as steel, petrochemicals, and chemical fibers. Many of the contracts from this period were concluded in great haste in late 1978 and were subsequently canceled or postponed.[5]

It is interesting to note that China's technology transfer experience with the Soviet Union was intimate in that it involved a whole range of transfer experiences (including the importation of whole plants, the supply of Soviet blueprints, the presence of Soviet technical advisors in China, and the training of Chinese in the Soviet Union). China's subsequent approaches to technology acquisition in the 1960s and 1970s were more at arm's length, focusing on the importation of complete plants and sets of equipment without due attention given to the software, training, and advisory services that often contribute to successful assimilation.

A number of changes in China's approach to technology transfer have been made since 1978. The Chinese came to the conclusion that the arms-length, whole-plant mode of transfer was too costly and did not yield the know-how they expected. Since then, Chinese policy has discouraged the acquisition of complete plants and equipment and has stressed the acquisition of know-how: "acquiring the hen and not just the egg," as the Chinese put it. Thus, modes of technology transfer that offer more intimate interactions with foreign technical personnel have come to be preferred. A wide variety of instruments of transfer, including licensing, joint ventures, cooperative ventures, wholly foreign-owned ventures, compensation trade, and the use of consultants and the procurement of technical services are being used. Much emphasis is being placed on foreign provision of training in contract negotiations of Sino-foreign technology transfer. As a result of this change, a much greater proportion of the technology imported since the end of the 1970s has been "unembodied" technology, or pure know-how.[6]

In addition, China spends a greater percentage of its resources on importing technology than it did in the past. In the sixth Five-Year Plan period, for instance, $9.7 billion, or 15 percent of the investment funds provided for in the plan, went for foreign technology.[7] Two other changes are notable in this fourth period of technology imports: Whereas past emphasis was on technologies supporting the establishment of new enterprises, the emphasis since the early 1980s has been on technologies to upgrade or renovate existing enterprises. Finally, the locus of decisionmaking on technology transfer has changed. As part of the reformist decentralizations, the central ministries and a single foreign trade corporation are no longer the principal decisionmakers. Instead, many other players have become active, including enterprises, local governments, and a myriad of new trading corporations.

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nology From Abroad and to Control Its Corruption of the Maoist Socialist Revolution," *Technology and Communist Culture: The Socio-Cultural Impact of Technology Under Socialism*, Frederic Fleron (ed.) (New York: Praeger, 1977).

[5] Huang Fangyi, op. cit.

[6] Ibid.

[7] Ibid.

INDIGENOUS CAPABILITIES: THE EXAMPLE OF THE DEFENSE INDUSTRY

The context for technology transfer cannot be understood without recalling the existence of significant technological capabilities indigenous to China. These include an extensive network of over 9,000 R&D institutes, including almost 120 in the Chinese Academy of Sciences, a large capital goods industry, and a military-industrial complex that has enabled China to develop nuclear weapons and launch satellites.

Over the years, Chinese industrial investment has been strongly biased toward heavy industry, resulting in the establishment of a large and comprehensive capital goods industry supported by a network of R&D institutes.[8] At the center of the capital goods sector is the vast machine building industry, the main domestic supplier of industrial technology and equipment and the chief alternative to foreign technology. Included in the machine building industry (see box A) are China's industrial assets for military production.

As part of the package of economic reforms, the Chinese have initiated a significant policy shift regarding the national defense industry. The latter had for many years been the beneficiary of priority investments of material and human resources. Commenting solely on the ordnance and aeronautics industries (just two of six main defense industry sectors), for instance, two Chinese observers noted:

> In the 1950s and 1960s . . . the State assigned the university graduates and the most outstanding scientific and technological workers to the departments in charge of the national defense industry, with the result that there was a concentration of talented people in the industry. At the same time, the Ministry of the Aeronautics Industry and the Ministry of the Ordnance Industry jointly owned a scientific and technological work force of more than 200,000. In addition, the best facilities and equipment went to the national defense industry.[9]

Until the late 1970s, however, this privileged sector had been largely insulated from the civilian economy and civilian R&D system. It thus had little impact on the latter in spite of technological achievements in the defense sector. China has produced military planes for 30 years but is only now starting to produce civilian air lines. It has designed and launched its own military satellites, but its telecommunications satellites are still experimental. It mastered nuclear weapons technology in the 1960s, but the first nuclear power station is still under construction.

In the post-Mao era, this situation has been changing. As the Chinese contemplated the modernization of national defense, they concluded that over the long run the nation's security could not be achieved without a vigorous and modernized civilian industrial economy. Defense modernization was therefore accorded the lowest priority position of the four modernizations. Cutbacks in defense procurement resulted in significant underutilization of defense factories. The latter therefore have been instructed to turn at least some of their productive assets to the service of the civilian economy.

The defense industry has become a vast empire of research and production units, but it is difficult to define their economic significance. Until recently, the Chinese rarely provided information on the defense industry, but as part of the "civilianization" program, more is coming to light. The extensiveness and degrees of vertical integration of the defense plants is depicted in a recent account of the "012 Enterprise Group," an industrial complex of the

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[8] A useful analysis of the capital goods industry, including its technological capabilities, is found in Zhang Renyu, *Technology Issues in the Capital Goods Sector: The Experience of the People's Republic of China*, United Nations Conference on Trade and Development, UNCTAD/TT/57, 1984.

[9] Chen Siyi and Gu Mainan, "China's National Defense Industry Faces an Historic Turning Point-Sidelights on Zhao Ziyang's Meeting With National Defense Industry Specialists," *Liaowang* Overseas Edition, No. 6-7, Feb. 10, 1986. In FBIS, Mar. 5, 1986, p. K14.

Box A.—The Structure of the Machine Building Industry

The machine building industry has been reorganized to reflect its changing military and civilian responsibilities. The former Ministry of Machine Building has been combined recently with the Ministry of the Ordnance Industry (which also includes the China Northern Industries Corp. and produces instruments and meters, precision metal cutting and forging tools, diesel engines, bicycles, clocks, washing machines, sewing machines, oil equipment, magnetic heads, tapes, and discs) into the State Commission of the Machine Industry. In addition, there are special ministries of machine building (formerly numbered, but now renamed to reflect their new mixed military and civilian roles) listed below. Each of these has set up one or more of its own corporations to link it to the civilian economy and, particularly, to facilitate its entry into international trade. These ministries, their trade corporations (in parentheses), and their civilian product lines are listed below. The range of sample products gives some idea of the high degree of vertical integration that characterizes these ministries.

1. Ministry of the Nuclear Industry (China Nuclear Energy Industry Corp.). Products include meters and instruments, surveying and mining equipment, optical instruments, mechanical components, nuclear reactors, air filters, valves, and heat exchangers.
2. Ministry of the Aeronautics Industry (China Aero-Technology Import and Export Corp.). Products include transport aircraft, agricultural aircraft, lathes, motorcycles, transducers, switches, optical recorders, washing machines, air-conditioners, and technologies for the auto industry.
3. Ministry of the Electronics Industry (China Electronics Import and Export Corp.). Products include earth stations, navigation equipment, electronic materials, computers and peripherals, radios, TVs, other consumer electronics, and integrated circuit technologies.
4. Ministry of the Astronautics Industry (Great Wall Industry Corp., China Precision Machinery Corp., China Communications Satellite Corp.). Products include expendable launch vehicles, communications equipment, weather and earth resources satellites, telemetry, tracking and control equipment, microelectronic devices, and dishwashers.
5. China State Shipbuilding Corp. (China Shipbuilding Trading Corp.). Products include bulk carriers, container vessels, marine engines, seismographic and meteorological support services for offshore prospecting, yachts, and pleasure craft.

SOURCE: Adapted from Wendy Frieman, "National Security Risks of Dual-Use Transfers to China," app. 6, vol. II of this report, July 1986.

aviation industry located in Shanxi Province.[10] The complex comprises of over 20 factories and employs more than 30,000 people, including 4,100 engineers and technicians. Included also are 10,000 major pieces of equipment and one of the largest assembly workshops of its kind in Asia.[11]

Such complexes have been assumed by outsiders to be characterized by a high degree of vertical integration. The full extent of integrated industrial capabilities is evident from the diversity of industries to which the 012 complex now supplies goods and services under the current policy of aiding the civilian econ-

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[10] Many of the defense-related facilities established in the 1960s and early 1970s were located in mountainous regions in the interior, for national security reasons. This industrial location policy, sometimes referred to as the "third front construction" policy, leaves China with a spatial distribution of important industries that is not economically rational under the current policies of integrating the defense industry with the civilian economy. The Chinese are taking special action to deal with these third-front enterprises; a special office for them has been established under the State Council, and there is special mention of them in the Seventh Five-Year Plan.

[11] Quan Zong, "China's Large-Scale Aviation Industry Base Deep in the Mountains—A Visit to the 012 Enterprise Group," *Liaowang* Overseas Edition, No. 26, June 30, 1986. In FBIS, July 15, 1986, p. K21, ff.

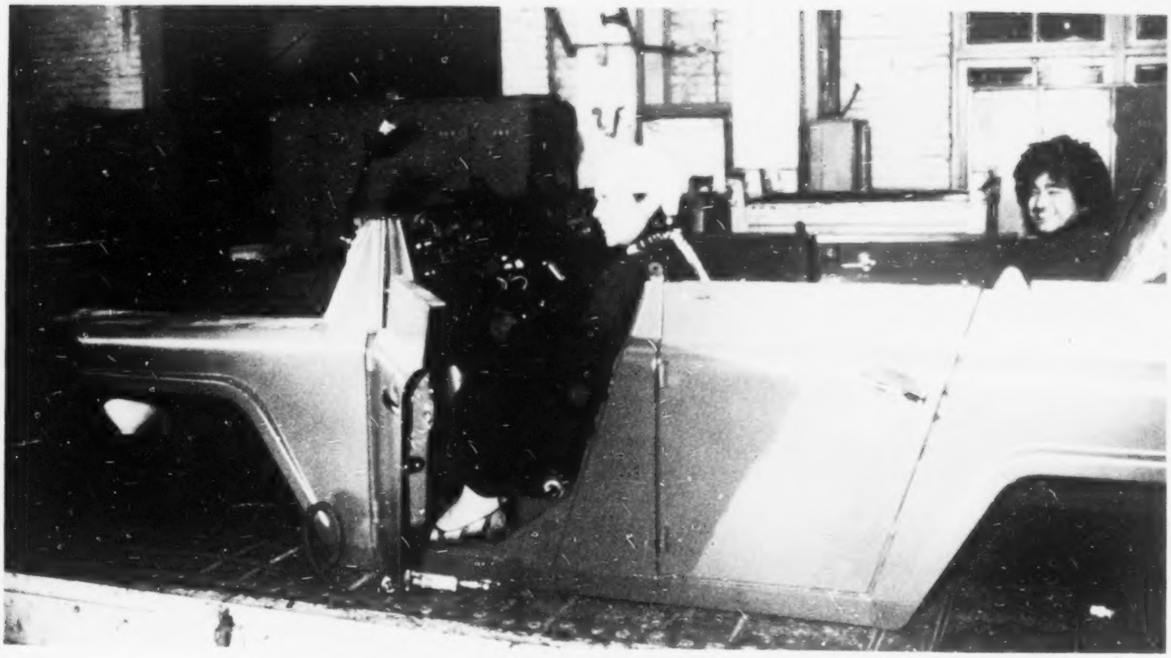

Photo credit: Eric Basques

Assembly of the BJ-212 jeep at the Beijing Automotive Works. This Soviet designed jeep has been produced for decades—annual output is set at 24,000 units. The assembly line has been shut down while these workers are on their lunch break, which in China is often 2 hours.

omy. Although one of the main products of the complex is the Yun-8 transport aircraft, member factories have produced such diverse products as light industrial goods (including copying machines), processing machinery, instruments and meters, home appliances, and farm machinery. The complex also cooperates with the textile, plastics, and food processing industries. A cooperative venture with the No. 2 Automobile Factory has been begun to produce minicars.

The degree of vertical integration in the defense industry and the privileged quality of this sector in the past may mean that there are "pockets of excellence"or special competence which will, under the new policies, begin to have more of an impact on the economy.[12] For instance, some of China's more advanced technological competence in computers and electronics may be in the Ministry of Astronautics (MOA), not solely in the Ministry of Electronics Industry, where one might expect it. According to one report:

> Great progress has been made in the manufacture and application of computers used in rockets, satellites . . . All special-purpose computers for military use are made by China. Some computers have reached the advanced level of the early 1980s. At present this ministry (MOA) has developed a system that incorporates research, production, and application of integrated circuits, whole sets of computers, and peripheral equipment and software. It is now capable of annually producing 5,600 microcomputers, and small and medium-sized computers, as well as 5 million integrated circuits. It has established three bases for producing integrated circuits, and has put more than 2,000 computers into operation.[13]

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[12] Denis Simon, "The Challenge of Modernizing Industrial Technology in China: Implications for Sino-U.S. Relations," Asian Survey, vol. 26, No. 6, April 1986, pp. 420-439.

[13] Beijing, *Xinhua*, June 13, 1986. In FBIS, June 30, 1986, p. K33. In January 1986, a U.S. delegation attending a science policy conference in China, which included a member of the OTA staff, visited a MOA facility in Lishan, Shaanxi province, where 3-micron circuits were being produced. The facility was in transition to civilian commercial sales.

MOA computer and electronic products are now being marketed throughout China and in 20 countries abroad.[14]

Clearly, such plants as the 012 Enterprise Group and the facilities of the MOA, as well as other parts of China's military industrial complex, have considerable technological potential that must be considered in assessing the prospects for technology transfer to China. The domestic suppliers of technology associated with the defense industry, and the machine building industry more generally, have the competence to meet many of China's technological needs, albeit not always as well as foreign technology. Nevertheless, the machine building industry consistently promotes itself and its capabilities as alternatives to foreign suppliers of technology, as the account of the 012 complex makes clear:

> In the past, the Wuhan Iron and Steel Complex imported spare parts for the cylinders of the hydraulic pressure systems of its rolling mills. The No. 572 factory under the 012 Enterprise Group undertook the task of the research and manufacture of the R2 main shaft balance cylinder. The balance cylinders it produced have been installed for trial use and proved to have a life of over 3 years, far longer than the 6-month life of the imported ones.[15]

Further evidence that the Chinese see the military industries and R&D institutes as important factors in the national technology transfer strategy is seen in the following editorial comment in *People's Daily*:

> At present, many enterprises have already attached importance to introducing advanced foreign technology. However, less attention has been attached to transferring our own defense industry technology to civilian enterprises. Transferring defense industry technology to civilian enterprises is a shortcut to enhancing technological progress, which should be accelerated.
>
> Introducing foreign technology is certainly a demand of the four modernizations. However, it has many limitations. We need to introduce many types of advanced technology, but since they are very expensive, we can only introduce what we most need. Moreover, the most advanced technology is usually unable to be introduced into our country. The transfer of defense industry technology to civilian enterprises has no such limitations. Therefore, we must energetically encourage this transfer. The more and the faster the transfer the better.[16]

Some of these ministries have made an aggressive entry into the civilian market. It is likely that this will continue and that the machine building ministries will have a more prominent role as exporters of goods, services, and technology during the remainder of the century. In the past, machinery and electrical products accounted for a small fraction of China's exports, representing only 4.7 percent in 1985. Current thinking, however, predicts a volume of machinery exports by 1990 worth US$1 billion, or a 240 percent increase over 1985.[17]

The Chinese are also striving to become exporters of technology and high-technology services. In April 1986 they convened their first technology export fair in Shenzhen, at which the defense industries were well represented.[18] China's offers to provide satellite launch services to overseas parties and the marketing of the diverse services of the nuclear industry are two of the more prominent examples of possible future exports of services from the military industry. While technology exports from China are unlikely to be exclusively from the defense sector, many will be. Ironically, given the production and managerial problems that have inhibited the actual employment of new technologies in civilian industries, it may be easier for the Chinese in the short run to sell technology developed in the defense industries than to sell products made in China employing that technology.

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[14] Ibid.

[15] Ibid., p. K22.

[16] Commentator, "A Shortcut To Enhancing Technological Progress—On the Necessity of More Quickly Transferring More Defense Industry Technology to Civilian Enterprises," *Renmin Ribao*, Aug. 27, 1985. In FBIS, Sept. 5, 1985, p. K2.

[17] "Interview With He Guangyuan, Vice Minister of the Machine Building Industry," Beijing Domestic Television Service, June 6, 1986. In FBIS, June 16, 1986, p. K16.

[18] Chen Zhiqiang and Yu Fengyuan, "Chinese Technology Moves Towards the World," *Renmin Ribao* Overseas Edition, Apr. 22, 1986. In JPRS-CST-86-025, pp. 17 ff. See also, a report on China's seeking patent protection services in Hong Kong for its technology exports in the *South China Morning Post* (*Business News* supplement), Apr. 1, 1986; and Huang Zhiping, "Chinese Technology Seeks Overseas Markets," *Intertrade*, January 1986, p. 29.

Products from the defense industry are likely to become an increasingly important part of China's exports. China is already a major arms exporter (see ch. 7), and recent reports indicate a desire to move to higher technology in its military exports. In some cases, this will be done with foreign help. For instance, China and Italy have entered into an agreement to upgrade the electronics and fire control system for the A-5M attack aircraft.[19]

China's new policy toward the relationships between the defense industries and the civilian economy not only has the potential for making the considerable technical resources of the defense sector available to the civilian economy, but also creates the possibility that the defense sector will become more innovative as it faces market demands, as it gains access to technology available in the civilian economy, and as it enters into cooperative technology transfer ventures with foreign firms.

Despite frequent statements from China that the technologies of the defense industries can often substitute for foreign technology, it is clear that the defense industries also see their current role as improving their technology through cooperative international civilian projects.[20] Thus, it is likely that the new policy on the defense industry will not only contribute to domestic transfers of technology to the civilian sector, but also lead to the upgrading of the technology and the management of the formerly exclusively military sector of the Chinese economy.

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[19] See, *Xinhua*, Nov. 6, 1986, In FBIS, Nov. 7, 1986, pp. K5-K6; and Daniel Southerland, "China Plans To Expand Arms Sales," *The Washington Post*, Nov. 12, 1986.

[20] For one account of the activities of the aviation industry, See *Intertrade*, December 1985.

THE DECISIONMAKING SYSTEM

Without a clear national consensus on the proper course for technology transfer, different perspectives and interests have led to a fractured decisionmaking system in China. Indeed, organizational complexity is often a dominant factor in China's relations with Western enterprises and is a major obstacle to China's modernization.

China's record of choosing, importing, and assimilating technology has been much influenced by the operation of its decisionmaking institutions, and particularly by the overlapping central and regional jurisdictions that characterize the decisionmaking system. For instance, coordination between the central ministries and between decisionmakers in Beijing and those at the province and enterprise levels has not always been good. Decisionmakers in Beijing who make purchasing decisions about foreign technology have not always had a good understanding of the technical problems in the field. There is a lack of coordination between the economic commissions at various levels of government and the science and technology commissions.[21]

The Chinese in recent years have sought to rationalize their decisionmaking for technology import policy, with mixed success. China's problems are in part a function of reconciling the many domestic bureaucratic interests in foreign technology into a coherent position.

A related problem is that of reorganizing a foreign trade bureaucracy that was set up originally to conduct trade with other socialist countries. In the original scheme, a centralized Ministry of Foreign Trade (MFT), which existed until 1982, was chiefly responsible for the conduct of trade and for the centralized allocation of scarce foreign exchange.[22] China's former

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[21] Song Jiwen, "Digestion and Absorption of Imported Technology—A Shortcut to Technological Progress," *Jingji Guanli*, Sept. 5, 1985. In FBIS, Nov. 4, 1985, p. K24.

[22] Samuel P.S. Ho and Ralph W. Huhnemann, *China's Open Door Policy* (Vancouver: University of British Columbia Press, 1984), p. 34.

MFT oversaw eight national foreign trade corporations specializing in different commodities. As trade expanded rapidly in the 1970s (from $4.59 billion in 1970 to $20.64 billion in 1978), the old system was not able to handle this increase and became an obstacle to further growth in trade. Gradually, foreign trade corporations were set up under other ministries, not directly under the MFT.[23] Further complicating the situation was the granting of greater trade autonomy to local governments as part of the decentralization experiments. To bring some coherence to this system, the old MFT was combined with three other central trade agencies in 1982 to form the Ministry of Foreign Economic Relations and Trade (MOFERT).

Yet uncertainties remain about how the system works largely as a result of a series of centralizations and decentralizations of foreign trade decisionmaking authority.[24] For both economic reforms generally and for technology imports, the Chinese are still searching for the right balance between centralization and decentralization and between the achievement of centrally determined values for the whole economy and the encouragement of local initiative.

The foreign trade apparatus also shows a tension between the influence of the planning system and the play of the market. China clearly plans some of its technology procurements. For instance, the SEC had an import plan for the 1983-85 period that contained some 3,000 items of technology for its national effort to renovate small and medium-sized enterprises. Planning targets for other types of projects were also established.

In recent years, however, as enterprises have been allowed to retain foreign exchange, there has been a drift toward a more decentralized, market-driven approach to technology acquisitions. This trend and the attendant fear that the center will lose all control over technology imports have led to recentralizing technology transfer policy and foreign exchange controls, including the 1985 regulations described below.

The Chinese system for decisionmaking on technology imports is very complex and, at least for outsiders, uncertain. In the cases considered for this report, OTA saw considerable confusion about how decisions are made. There was also evidence of decisions being changed, sometimes because of changed circumstances, but also because of the underlying fluidity of the decisionmaking system itself.

Decisionmaking procedures vary according to the size of the project and the type of control over the project (central or local). Often, but not necessarily, these variations can be explained by the type of industry involved. The electronics industry, for instance, has experienced considerable decentralization in recent years, while the energy industry has retained greater centralization.[25] Decisionmaking also varies according to the mode of transfer being used; decisions concerning joint ventures, for instance, will involve different procedures and regulations from those involving licensing.

A further complication is the relationships that exist between the end user of the technology and the (often multiple) organizations that have jurisdiction over the end user. In addition, the making of a decision can be thought of as having stages—consultation, negotiation, ratification, implementation, evaluation—that often involve different participants.[26] Finally, the system is complicated precisely because in basic ways it is changing.

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[23] Ibid., p. 35.

[24] Foreign trade reforms begun in 1980 opened the way for more Chinese companies—those under both central and local control—to participate in foreign trade. Companies wishing to enter into foreign trade must get the permission of MOFERT, or a local government, and then must register with and get a license from the State Administration of Industry and Commerce. Once licensed, they may open foreign exchange accounts. Import licenses are required for 42 categories of goods, and export licenses are needed for 235 categories.

[25] Cf., Denis Fred Simon and Detlef Rehn, "Understanding the Electronics Industry," *The China Business Review*, March/April 1986, pp. 10-15; Oksenberg and Lieberthal, *Bureaucratic Politics and Chinese Energy Development*, report prepared for the U.S. Department of Commerce, International Trade Administration, August 1986.

[26] See, Roy F. Grow, "Transferring Foreign Technologies: Steps in the Chinese Decision Making Process," unpublished paper presented at the conference on *China's New Technological Revolution*, Harvard University, May 9-11, 1986.

For instance, until recently, the role of the banking sytem was not central. However, with economic reform, which has increased the role of the banks in the running of the economy generally, banks—especially the Bank of China—have also become important in foreign trade and technology imports.

Perspective of the Enterprise

An enterprise may not always wish to incorporate new technology into its operations. In an economy of shortages, as has been the case for some time in China, producers can sell whatever they produce, giving them little incentive to assume the risks and costs of technological change.

If a decision is made to acquire new technology, several practical decisions must follow. How quickly can the technology be procured? How easily will it be absorbed or assimilated? What level of technology should be chosen? How will it be paid for? Should it be procured domestically or internationally? The economic and technical reasons for importing technology include domestic market competition and, increasingly (as a result of government pressures to export), international market competition. Foreign technology generally results in better products. In addition, it clearly carries a great deal of prestige. An increasing number of Chinese firms are establishing "technology introduction offices" to aid in acquisition decisions.

Apart from the central question of what market exists for the enterprise's products, the Chinese environment has to be considered. Is the technology available in China? Has it been targeted as a high priority by the Chinese Government? Will it be addressed by the nation's R&D system? How much pressure does the enterprise feel to increase its exports? What kind of access does it have to foreign exchange? Can the enterprise get special benefits from the state by procuring the technology? The enterprise must also anticipate that these issues will be assessed by the layers of bureaucracy (local or national, and sometimes both) that must approve the enterprise's project.[27]

Furthermore, the international environment must be considered. Is the technology available internationally, and are there agents (companies, governments) willing and able to transfer it? What mode of transfer is most appropriate for the technology, and is the adoption of that mode feasible? In this international context the importance of export controls comes in.

Hidden factors exacerbate delays from the enterprise perspective. Once a decision is made to import technology, which can be a lengthy process, the decision has to be approved by higher authorities to assure consistency with national policies, particularly those pertaining to types and levels of technology and to the expenditure of foreign exchange.[28] Thus, well before a contract would actually be signed, and indeed in some cases well before negotiations with foreign firms begin, the enterprise would have gone through considerable negotiations within its own system; anywhere from 6 to 18 months would already have passed. If the enterprise must then wait for a protracted export license decision, it could face delays of 2 years or more before the technology arrives. Given the complexities at the enterprise level, it is unlikely that there would be a simple, consistent set of benefits for choosing one technology over another.

The willingness of decisionmakers to take risks is also an important factor. China's economic system over the years has structured incentives in such a way that decisionmakers are often risk averse. Risk aversion has been further encouraged by the history of unpredictability in Chinese politics, which has made managers unwilling to take individual actions that could expose them as targets of a future radical political campaign. Foreign partners in joint ventures have reported risk aversion and a lack of initiative among middle managers as factors slowing the absorption of technology at the enterprise level. The present uncertainties are likely to aggravate this timidity.

Perhaps the most crucial factor in decisionmaking during the last few years is the availability of foreign exchange. Despite severe foreign exchange regulations, there are an increasing variety of viable strategies for obtaining foreign exchange. Some enterprises, for a variety of reasons, will be more privileged in their access to foreign exchange than others, and the technologies they demand will therefore tend to have a high priority. Central authorities are therefore challenged to ensure that the country's foreign technology needs are not determined by the pattern of availability of foreign exchange; what is best for China may not be what is best for the enterprise with foreign exchange.

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[27] Simon and Rehn, op. cit.

[28] Ibid.

The foreign exchange constraint also has a more indirect and often detrimental effect on technology transfer behavior. Because of its shortage, foreign exchange is rationed. When projects are approved, but not necessarily before a foreign vendor is chosen and contracts are signed, enterprises are given quotas for use in going ahead with the project. There are some indications that the technology transfer strategies of Chinese enterprises are determined more by considerations of how to use the quota than by how to save foreign exchange and make the introduction of the technology part of an economically progressive decision.

In one case, an American firm that took pains to package a sale with a selling price factored in both hard and Chinese currency (in order to help the Chinese save on foreign exchange) lost the sale to a Japanese firm that offered a somewhat lower total price but insisted on hard currency for all of the settlement. The foreign exchange cost to China was thus higher, although the sale price to the enterprise was lower. Since the enterprise had a quota that had to be used (or lost), it had no incentive to save on foreign exchange. In other cases, the Chinese foreign exchange allocation system seems to have led to the overvaluing of hardware transfers relative to software, despite policy to the contrary. In accounting for the use of foreign exchange to procure technology, it is easier to point to a piece of equipment than to something as amorphous as know-how. Foreign exchange limitations at the enterprise level also keep enterprises from buying all the support items necessary for making the projects work.

The Government Perspective

Chinese authorities in recent years have tried to bring central policy guidance and coherence to the business of importing technology, issuing a variety of new policy statements and regulations. From the perspective of the central government, the main principles for choosing foreign technology include the following. Technology to be imported should:

1. be above the level of that which is available in China;
2. be of practical use;
3. contribute to China's eventual self-sufficiency;
4. foster economic and social development; and
5. be useful for generating foreign exchange.

Judgments about how to apply criteria such as these become part of the technology import decisionmaking process, and periodically various agencies, particularly the State Science and Technology Commission (SSTC), are called upon to interpret these guidelines in specific cases.

As part of an effort to protect both China's interests (particularly regarding restrictive business practices by foreign firms) and the proprietary interests of foreign suppliers of technology, the Chinese State Council on May 24, 1985, promulgated new "Regulations of the People's Republic of China on Administration of Technology Acquisition Contracts." These regulations call for their administration by MOFERT, which subsequently drew up its "Measures for the Examination and Approval of Contracts for the Import of Technology," which took effect on October 1, 1985.

The regulations set criteria for the kinds of technology to be imported, limit the normal life of the technology transfer contract to 10 years, offer protection to foreign technology that falls outside the patent system, and charge MOFERT with establishing a system for reviewing and approving technology transfer contracts. As of this writing, it is still too early to judge the longer term effectiveness and the consequences of these new procedures.

努力建设高度的社会主义物质文明！
ENDEAVOR TO BUILD THE HIGHLY-DEVELOPED SOCIALIST MATERIAL CIVILIZATION

Photo credit: Eric Basques

This sign is posted on the grounds of the Beijing Jeep Corp.

Some of their ambiguities have been noted,[29] and complaints have been heard that demands by MOFERT for guarantees that the technology transfer will be successful place a heavy burden on the foreign supplier and lead to higher costs.[30]

The regulations do seem to strengthen the hands of the central government over enterprises and localities. It also seems that the regulations were inspired by China's examination of the experiences of other developing countries that tried to centralize authority over technology transfers to protect national interests from the economic power of multinational enterprises.

The most important organizations for technology transfer decisionmaking in the central government are the State Planning Commission (SPC), SEC, MOFERT, and SSTC. In addition, the ministries having cognizance over the technology in question also play an important role. For very large projects or projects of special national importance, decisions would be elevated above the SPC level to an appropriate level, such as the Leading Group for the Invigoration of the Electronics Industry, or the Science and Technology Leading Group, or perhaps to the State Council itself.[31]

The role of the SPC in the Chinese economy is to prepare 1- and 5-year economic plans and to assure that financial, material, and human resources are made available for the execution of projects included in the plans. This includes annual authorizations to expend foreign exchange. Since the SPC can give only limited attention to specific project proposals for importing technology, it focuses on strategic commodities[32] and technology transfer projects with a value of US$5 million or more. There are exceptions to this $5 million figure, however. The central government has delegated to the Shanghai municipal government, for instance, the power to approve projects up to the limit of US$10 million and the power to approve joint venture projects up to $30 million (selected other cities have approval powers over joint ventures up to $10 million).[33]

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[29] Ellen R. Eliasoph and Jerome Alan Cohen, "China's New Technology Import Regulations," *The China Business Review*, vol. 12, No. 6, November-December 1985, pp. 36-40.

[30] Foreigners also complain about the lack of transparency in decisions about what kinds of preferences the Chinese are prepared to grant or withhold in contract language, and call for more standardization on the contract language.

[31] For a good overview of Chinese central government decisionmaking, and the responsibilities of the key central agencies, see, Oksenberg and Lieberthal, op. cit.

[32] Ibid., p. 37.

The SEC has traditionally implemented the plans. In recent years, the SEC has also assumed both the leading role in implementing the economic reform program and the reponsibility for introducing modern management to Chinese enterprises. Its most direct role in technology transfer decisionmaking, however, is related to its responsibility to see to the technological transformation (*jishu gaizao*) of established Chinese enterprises.

The SEC has a special office, the Technical Transformation Bureau, and a special budget for technological transformation, including a foreign exchange account for importing technology that contributes to *jishu gaizao*. During the Sixth Five-Year Plan, the SEC had responsibility for 3,000 transformation projects; another 3,000 are included in the Seventh Plan. During the last 2 years of the Sixth Plan, some US$5 billion per year was spent on enterprise renovation; the total number of technology import projects for the whole plan was 14,000.[34] The Chinese expect that this effort will be surpassed during the Seventh Plan.

Thus, technology import projects that fall under the category of technological transformation are approved by the SEC unless they exceed the $5 million-value limit. Ministries and enterprises wishing to undertake technological transformation projects using imported technology submit feasibility studies to the SEC or to economic commissions of local governments.

The mission of MOFERT is to plan and administer foreign trade. Through the activities of its Technology Import and Export Department, it provides policy advice on China's needs for a given technology, its ability to absorb the technology, and the likely overseas sources.[35] MOFERT also approves the language of technology transfer contracts to ensure that it conforms with the country's regulations, and it takes the lead in proposing new regulations or revisions and clarifications of existing regulations. It also serves as the cooperating partner with the U.S. Trade and Development Program. In addition, it certifies Chinese end users of sensitive high-technology transfers in keeping with understandings reached with the Coordinating Committee for Multilateral Export Controls (COCOM) as part of the latter's liberalization of export controls.

The SSTC does not have a direct ongoing role in decisionmaking for the import of commercial technology, but is an important participant nonetheless. It is centrally involved in importing technology for the national research and technological development projects it controls and can also play a decisive role in providing technical assessments of important pieces of technology to be imported. Further, the SSTC plays a key role in setting national technology policy. This includes statements of priority about which technologies China should expect to have by the end of the century and whether these will be acquired by importing technology or by developing it indigenously. These statements of policy serve as points of reference for the SSTC's own assessments of proposed projects and also guide the decisions of other participants in the system.

Many enterprises in China are local rather than under central control. The local government level has counterparts to the central government decisionmakers discussed above. These include planning, economic, and science and technology commissions; a bureau of foreign trade; and enterprise bureaus for different industries. In some cases, as with the central government, a corporate organization may exist between the enterprise and the industrial bureau. The level of decision will depend on the value of the transaction. In all cases, however, the contract must be approved by the foreign trade bureau.[36]

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[33] In spite of the delegation of decisionmaking authority to local governments on the basis of the value of projects, the central authorities remain more involved in decisions than the rules of delegation would suggest. See, Simon and Rehn, op. cit.

[34] Sun Zonghao, Director, Technical Transformation Bureau, SEC, "China's Technological Imports and Vistas for Development," unpublished paper presented at the MIT Seminar on Technology Transfer, April 1986.

[35] Oksenberg and Lieberthal, op. cit., p. 90.

Financial and Trade Organizations

The Ministry of Finance has attempted to make technology import policy sensitive to the costs of technology transfer, with regard not only to the direct procurement costs, but also to the costs of absorption.[37] The Ministry of Finance has also attempted to establish the principle that technology imports should lead to expanded exports.

The Bank of China has become the key financial institution responsible for the distribution of foreign exchange and has an institutional interest in the financial soundness of technology import projects. The bank's role has been enhanced by the increasing reliance on the banking system, instead of the state budget, for investment. When projects are approved by the SPC or the SEC (or their local counterparts), a foreign exchange quota (*e du*) is established with the bank, which the enterprise can then draw on. The bank, however, reserves the right to conduct its own feasibility studies before dispensing moneys from the *e du* if it is dissatisfied with the feasibility studies that have already been done. In some cases, the bank also sits in on discussions much earlier in the project approval process.[38]

Other important participants in the decisionmaking system are the foreign trade corporations (FTCs). Some of these, such as the China National Technical Import Corp., which specializes in technology imports, and the China National Machinery Import and Export Corp. are under the control of MOFERT. Others are under the control of the various industrial ministries. The trading companies are often the bodies that negotiate and actually sign a contract with a foreign company, and they are at times tasked by the end users, who help identify possible vendors of technology. In this sense, they act as middlemen. In recent years, however, there has been much more direct interaction between the end user and the foreign vendor, even in cases where the trading company still actually signs the contract.

Foreign Firms

Foreign firms differ in their motives and strategies for transferring technology. Some firms approach technology transfer as the sale of a commodity without presuming any equity participation in the Chinese economy. The appeal of the transaction may be tied to other corporate objectives, but basically it is a sales relationship.

For other firms, China is seen as an export platform and source of supply for components and finished goods. Such firms can be expected to transfer technology needed to accomplish those business objectives. In these cases the firms can be expected to be earners of foreign exchange for China, although, as the Beijing-Jeep case demonstrates, they may also require substantial amounts of foreign exchange during the startup period.

Other firms may be more interested in China as a source of raw materials. They too can be expected to be earners of foreign exchange, and may, if required by the Chinese, be willing to transfer technology. The foreign oil companies that have participated in Chinese offshore oil development fall into this category. In this case, a great deal of the technology is in the form of the experience of the personnel of the companies, something that cannot be transferred readily except imperfectly via training. A small portion of the technology of the oil companies, such as exploration technology, is highly valued and highly perishable proprietary information that companies normally refuse to transfer. The Chinese have been considerably disappointed over the implementation of the technology transfer provisions in the offshore oil development case because of Chinese misunderstanding about the nature

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[36] According to Oksenberg and Lieberthal, in the late 1970s, the Ministry of Finance calculated that China should be prepared to spend four *yuan* of *renmin bi* on absorption, for every one US dollar's worth of technology and equipment imported. Ibid., p. 62.

[37] Ibid., p. 97.

[38] CF., Simon and Rehn, op. cit.

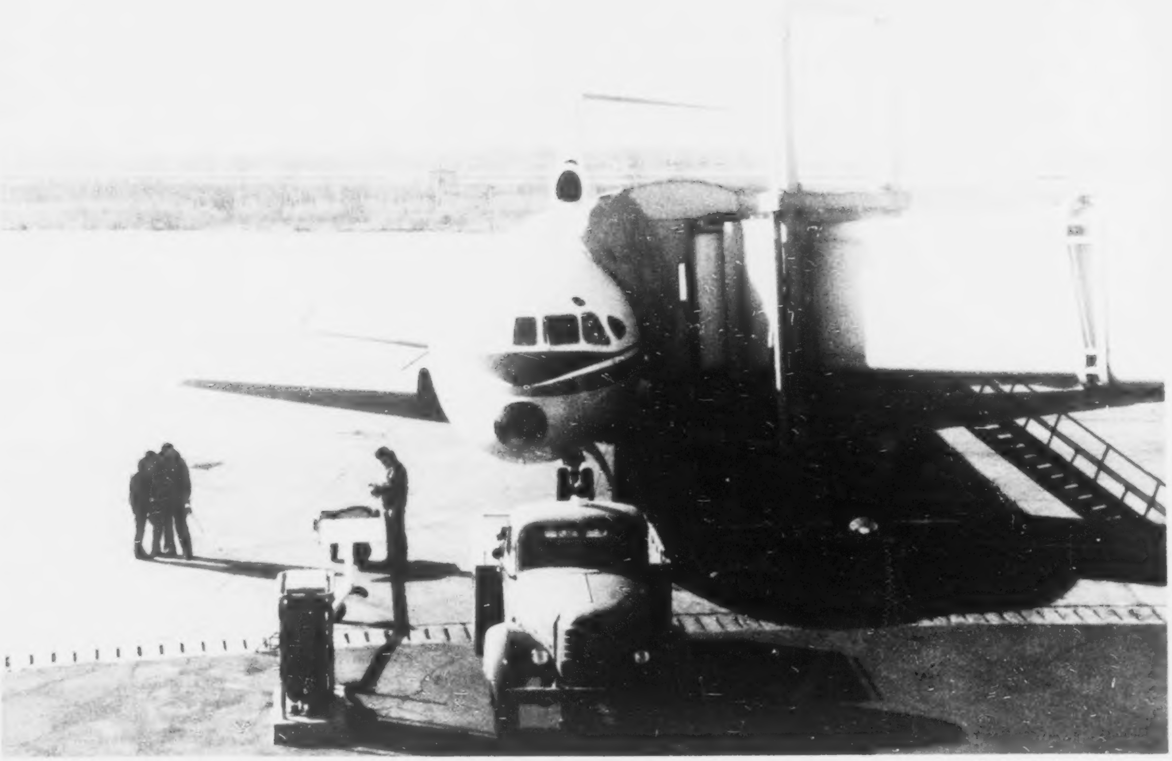

Photo credit: Eric Basques

A jet airliner prepares for passenger boarding at the Beijing International Airport. The truck is a model produced until recently that was based on Russian technology of the 1950s.

of the technology and a failure of the oil companies to understand Chinese expectations.

Other industries have different dynamics. In some areas of high technology where the Chinese have a keen interest, the very identity of the foreign firm is tied to its technology. In these industries—electronics, materials, telecommunications, biotechnology—there is great expense involved in product development and a rapid rate of product obsolescence. Markets must be expanded to distribute costs. In such highly competitive cases, technology is not viewed as a commodity to be sold, and there is great reluctance to transfer technology unless it will lead to a long-term presence in China with opportunities to design products for the Chinese market and to repatriate profits. It also requires Chinese partners who have the organizational flexibility to respond to rapidly changing technologies and business opportunities.

There are some signs that China is coming to appreciate this diversity of motives and strategies among foreign firms. The new investment regulations, for instance, recognize the difference between export-oriented and technologically advanced firms that need access to the domestic market. However, there is still much in the nature of Chinese policies and in the Chinese economic and political systems that makes it difficult to accommodate the diversity of technology transfer issues.

The Foreign Exchange Constraint

Since the end of 1985, concern over the availability of foreign exchange has become an even more important element in decisionmaking about technology imports. The officially preferred way of making a decision to import technology has been to fold it into the normal planning process. If a positive decision is made on a project, then in principle the necessary foreign exchange to implement it will be provided. However, it is precisely because foreign exchange costs are a factor in judging the desirability and feasibility of the project that decisionmaking through the planning system has in recent years been biased toward projects that promise to earn foreign exchange quickly. Thus, until recently, petroleum and coal projects promising to produce exportable commodities have enjoyed a privilege denied to electric power.

This bias of the planning system is one reason why enterprises, corporations, ministries, and local governments might find it in their interest to have decisions made outside of the planning system. There are also two other reasons. First, receiving formal plan approval can be time consuming if decisions on new projects are desired at a time out of phase with the planning cycle. In addition, present economic reforms are creating an environment in which enterprises often (though not always) wish to practice as much of their new autonomy as possible. To a considerable extent, they can do this if they have access to foreign exchange. The question of access to foreign exchange therefore becomes quite important for understanding decisionmaking.

As noted above, the SPC has the major role in allocating the right to expend foreign exchange to ministries, enterprises, and local governments. For the enterprise that wishes to import technology, therefore, one source of foreign exchange is that which is provided in the plan. For projects that have been included in the plan, provision is made, in principle, for the foreign exchange necessary to carry it out. This solution may not be optimal for more complex joint venture projects, where foreign exchange needs may be very fluid.

Enterprises can also earn foreign exchange themselves. The tight restrictions on foreign exchange imposed by the state in the last 2 years can be thought of as an incentive for enterprises to become more active foreign exchange earners, though they are allowed to keep only a fraction of their earnings and may need permission to spend even that. The enterprise can also approach the local government or the supervising ministries for out-of-plan foreign exchange, although the accounts held by these entities may not be large. Beijing, for instance, had only $100 million at its disposal.

In addition, the enterprise can attempt to buy foreign exchange from other units using local currency (*renminbi*) at a rate set by the Chinese Government. Or foreign exchange can be borrowed from the Bank of China if the bank approves of the project. In such cases, repayment is usually made in foreign currency. Other agencies, such as the China International Trust and Investment Corp. (CITIC), which have floated loans from foreign banks, are also prepared to lend foreign exchange.

It is clear that changes are occurring in the allocation of foreign exchange, just as in the economy as a whole. This does not necessarily mean that there is less overall central control over the total amount of foreign exchange expended. Within that total, new mechanisms for allocation are appearing, which may lead to more efficient use of the foreign exchange available. These new mechanisms complicate the task of trying to understand how the decisionmaking system actually operates, however.

The System in Practice

The decisionmaking system is supposed to operate as follows: Proposals for the import of technology originate in an enterprise under one of the central ministries or units of local government. The enterprise, however, is working under control figures that have already been supplied by the SPC (or local authorities) as a guide to enterprise planning. In developing the proposal, the enterprise typically must demonstrate the feasibility of the project through a feasibility study. The project must then be submitted to the ministry or local enterprise bureau (or in some cases, a corporation under a ministry of which the enterprise is a part) for approval. The approving authority at this level may also conduct its own independent feasibility study. For local enterprises, the project must then be approved by the local planning committee. If the project (whether from a locally or centrally controlled enterprise) exceeds $5 million,[39] it must be submitted to the SPC for approval, and the SPC may also do its own studies as to the desirability and feasibility of the project.

For projects pertaining to the technological transformation of industry, the proposal would go to the SEC. For projects below the $5 million level that do not pertain directly to technological transformation, the approval decision would be made at the level of the ministry, a national corporation, or a local government.

After substantive approval by one of the bodies mentioned above, a contract defining an agreement with a foreign partner must be submitted for MOFERT (or local foreign trade bureau) review, which involves a comparison of the terms of the contract with criteria expressed in policy regulations.

It is difficult to say with confidence that the decisionmaking actually works the way it is designed to. Furthermore, the system is changing as reforms in the economy progress and as new approaches and new participants appear. Banks have clearly emerged as more important parties, and relatively new organizations, such as CITIC, also influence the way the system operates. In addition, the decisionmaking system is embedded in an environment of bureaucratic struggles and shifting alliances, making the decision process, as well as the outcome of a decision, difficult to predict.

Despite much serious effort to establish policies and institutions for importing technology, the current Chinese system has become the object of criticism from outside and inside China. The criticism from outside, discussed in chapters 2 and 4, focuses on the impediments to doing business in China. The criticism of the current system from within China focuses more on whether the current system for technology transfer serves Chinese interests. Apart from those criticisms inspired by desires to protect domestic industries and R&D facilities from foreign competition, the more disinterested commentaries on the current situation focus on three main issues: the problems of duplication of imports, the negative consequences of decentralization, and the problem of assimilation.[40]

The problem of duplicative technology imports has been particularly evident in consumer-oriented light industry. Reportedly, over 100 color television assembly lines were imported since the late 1970s. If all were put into operation, they would more than saturate the market. To make matters worse, many of the components could not be made in China and had to be imported, resulting in a waste of foreign exchange. Similar problems were encountered with other consumer appliances, such as refrigerators and washing machines. Strong local interest in the production of floppy disks for computers has led to the proliferation of small plants to produce them, thus losing economies of scale.[41]

A related example is the field of optical telecommunication technologies. In this case, three different Chinese organizations have been negotiating with three different foreign companies, from the United States, Japan, and Europe. Instead of coordinating their efforts, they are all going separate ways, with the possible result of duplication and excess capacity. Since this area of technology has been identified as a national priority, two units of the central government have been charged with overseeing the importing of this technology. However, because these central authorities are linked to the organizations involved with the negotiations, they are unlikely to be disinterested arbiters and coordinators.[42]

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[39] Except in those jurisdictions, such as Shanghai, which have been delegated authority to make decisions on higher valued projects.

[40] This discussion is drawn from a three part article by Cao Jiarui entitled, "The Present Condition of, and Problems in China's Technological Imports," published in the overseas edition of the journal, *Liaowang*. Part 1 appeared in No. 18, May 5, 1986, and was translated in FBIS, May 16, 1986, p. K5 ff. Part 2 appeared in No. 19, May 12, 1986, translated in FBIS, May 22, 1986, p. K10 ff. Part 3 appeared in No. 20, May 19, 1986, translated in FBIS, May 30, 1986, p. K13 ff.

[41] Cao Jiarui, Part 1, op. cit.

The current critiques of the decisionmaking system for technology imports reflect the underlying problems of Chinese institutional weaknesses and jurisdictional confusion seen elsewhere in this report. A recently reported case involving continuous casting technology used in steel plants illustrates this point. In this case, China imported the technology from West Germany in 1980 under a cooperative production arrangement. The technology was assimilated to the extent that the Chinese reproduced and employed the technology successfully in other steel mills. As is often the Chinese custom, the achievement was publicized as a case of how foreign technology can help China and how successful assimilation can be accomplished. On the basis of this success, the State Council issued a directive in 1981 to the effect that in the future, if steel plants need this type of continuous casting machinery, they should first try to acquire it in China.[43]

In 1985, by which time the decentralizing of decisionmaking on technology imports had been implemented, a Chinese steel plant was in need of a continuous casting machine of the type that had by then been sucessfully produced in China using the original German technology. Instead of looking for a Chinese supplier, however, the plant decided to import the machinery, in violation of at least the spirit of the State Council directive. The justification for going to the foreign supplier was that the foreign equipment had certain technical characteristics allegedly not available in China.

To proceed with the purchase, the plant had to secure the approval of the provincial authorities only. The first step was to conduct its own feasibility study. This was then followed by an approach to the provincial branch of the bank, which conducted its own assessment and report. Finally, the provincial economic committee gave the plant approval to proceed again, seemingly in violation of central policy.[44]

Information is not available on the technical differences on whether the plant, the branch bank, or the provincial economic committee were unaware of the State Council directive or simply chose to ignore and circumvent it. Nor is it known whether the plant and provincial authorities genuinely believed that the foreign technology was most appropriate, whether they were attracted to the foreign technology simply because they assumed it was best because it was foreign, whether there was some form of corruption involved, or whether the authorities were simply incompetent to evaluate the proposed transfer in light of China's own capabilities. Any or all of these explanations are possible, given a variety of reports from China in recent years. What is clearer, however, is that from the central government perspective, this is the kind of experience that leads to duplicative imports that unnecessarily drain foreign exchange reserves.

Would the decision have been more in keeping with the national interest if there had been greater centralization? The answer to this question is not certain. The answer would almost certainly be positive if the center had a limited number of such cases to decide and could devote the necessary resources to information gathering and analysis. However, the number and variety of technology import cases clearly are far greater than the central authorities can handle. Central planner incompetence and ignorance of local particularities is precisely the weakness of centrally planned economies, and the main justification for decentralization. While the central authorities can and do rectify grievous mistakes, as they have now done in the TV, refrigerator, and washing machine cases, routine and efficient central direction of technology imports is seemingly beyond the capacity of the system.

China has had difficulty finding an institutional formula that would allows effective central policymaking, the observance of these policies in their implementation, and the flexibility of decentralized decisionmaking. The problem is the one alluded to in the previous chapter, that of the legacy of past decentralizations that empowered local (especially provincial) governments.

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[42] Ibid.

[43] Ibid.

[44] Ibid.

The Chinese sometimes refer to the structure of economic authority in China as a checkerboard, meaning that vertical authority emanating from the central government through ministries and commissions is crosscut by the horizontal interests of local or regional authorities. This system is sometimes also referred to as *tiao tiao kuai kuai*, literally "branches and lumps," in which the central ministries and commissions are the "branches" and the "lumps" are formed when these are crosscut by regional authorities. As one commentator put it, "The crucial point of our existing system is the division of departments (read ministries) and regions, which develops into a series of complicated contradictions between different departments (ministries), between department and region, and between different regions."[45]

This system of institutions has the effect of constraining the decisionmaking effectiveness of all parties and explains why even in periods of greater centralization, central authority is not necessarily determinative even on high-priority matters.

Not surprisingly, Chinese perceptions of institutional deficiencies differ. From the perspective of the production enterprise, decentralization has not gone far enough, since the enterprise's own autonomy is constrained. If the enterprise is under the jurisdiction of a local government, it is constrained by the interests and prerogatives of the latter, as well as by national policy. If the enterprise is under the jurisdiction of a central ministry, it is constrained by the interests and practices of the ministry and by overall national policy. However, it is also subject to the discretion of the local authorities, who typically would have a say in the management of the enterprise's personnel matters and in the supply of such goods as water and electricity. From the view of central planners and high-level economic and technology policymakers, on the other hand, the impression is one of fragmentation, with authority dispersed among ministries and regions.[46]

The current economic reforms and efforts at political institutionalization would seem to promise some improvement in decisionmaking. However, the record to date is mixed. For instance, management of Chinese industry has in many cases been removed from government ministries and vested in new corporate entities, which in principle are to run as profit-making organizations. However, these have not always been able to escape the heavy hands of party cadres, who want to maintain old ways of doing things even as the forms of organization change. Efforts are being made throughout the government and the economy to promote younger, more technically qualified, and more entrepreneurial individuals into managerial positions. On the other hand, the economic system still does not generate the economic information on which managers can base sound technology transfer decisions, nor the incentives for managers to assume the risks of innovation.

The now-standard insistence on feasibility studies for technology import decisions is intended to inject additional technical judgments into decisions and to force the attention of more interested parties on assimilation problems. The mechanisms for horizontal technical communication, noted in the next section, also aid in Chinese decisionmaking. Although this was not true in the late 1970s, decisions about importing technology are often informed by some of the best technical judgments in China. This is largely a result of the growth of consulting and advisory services.

However, the best technical judgments do not necesarily result in the the most appropriate technology decisions, and it seems that the full integration of technical, economic, and political criteria remains something of an ideal. There are some reports, for instance, that feasibility studies are not always taken seriously and are used for manipulative purposes. The prevalence of this practice, not unheard of in other countries, is not known.

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[45] Ibid.

[46] Cao Jiarui, Part 3, op. cit.

A summary assessment of China's decision-making system for technology imports is difficult. The system is composed of elements of centralization and decentralization, of market principles and planner influences. An optimistic interpretation is that it can be thought of as a transition to a more market-driven, decentralized system. This interpretation is clearly consistent with the intent of current policy, and much Chinese reform experienced since 1979 provides evidence for it.

The pessimistic interpretation is that the system is stymied, stuck between the imperatives of centralization and decentralization, of market and plan. In this view, the inertia of the established institutional setting is so great, and its power so entrenched, that reform policies cannot be fully implemented. Instead, reform impulses from the center will be distorted at various points in the system, producing undesirable and unanticipated consequences of the types noted above.

ISSUES OF ASSIMILATION AND DIFFUSION

Acquiring technology is only half of China's problem. Once transferred, the technology must be assimilated and diffused effectively if China's modernization goals are to be achieved.

The question of assimilation is linked to the underlying issue of technological dependency on the foreign suppliers of technology. Since the end of the 1950s, China has been particularly sensitive to this issue of dependency and has striven to avoid it. Ironically, however, the policies and institutions established in the past to foster self-reliance are now obstacles to the full assimilation of technology under the new assumptions of the open-door policy. The risk of dependency thus increases as the problems of assimilation remain unsolved.[47]

In discussing the assimilation of technology, it is useful to distinguish between production (using the imported technology), manufacturing (replicating the import), and design (the capability to redesign the technology).[48] Overall, China's ability to assimilate production technology has been greater than its ability to absorb manufacturing or design technologies. However, it is also useful to recall the various periods of Chinese technology imports, since assimilation experience has varied somewhat from period to period.

The Chinese seemingly did better at assimilating all three types of technology during the 1950s than in the subsequent two periods. Soviet provision of blueprints, technical advisors, and training programs undoubtedly contributed to this success. On the other hand, the technology transfer experiences of the 1960s and 1970s were not notably successful in terms of thorough assimilation.[49]

China's past history of importing technology suggests that many factors influence effective assimilation.[50] Choosing the right technology at the outset is clearly important. Many of the cases of unsuccessful assimilation were due to procurement decisions made by technically unqualified people, which resulted in the import of technology having the wrong properties for the intended task. Also, the Chinese underestimated the value of expertise relative to hardware, and neglected the support items necessary to make assimilation successful.

A second concern has been that managers have not been willing to make the effort to fully absorb the technology. That is, they have been

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[47] Zhang Shihong, "A Noteworthy Issue: Digestion, Absorption and Renewal in Technology Importation as Viewed From Shanghai," *Renmin Ribao*, May 3, 1985. In JPRS-CST-85-027, Aug. 22, 1985, p. 62.

[48] K.C. Yeh, "China's Assimilation of Foreign Technology, 1950-1985," paper presented at the conference on *China's New Technological Revolution*, Harvard University, May 9-11, 1986.

[49] Ibid.

[50] This discussion is drawn from Ibid.

more interested in expanding output by exploiting the production technology without attending to the acquisition of the underlying manufacturing and design know-how. Imported technology has been seen as a shortcut to technical progress. Yet, effective assimilation requires focused attention to the problems of absorption. In addition, it requires communication and cooperation among a variety of organizations, such as enterprises, research units, government agencies, and universities. China's segmented society has often frustrated the meeting of this requirement.

Another problem has been the lack of adequate managerial know-how to employ the technology fully. This was less of a problem in the 1950s since the Chinese imported Soviet management along with the technology and had the services of Soviet advisors. In subsequent periods, however, Chinese managerial backwardness became a hindrance.

China's past experience also points to the importance of having domestic R&D resources committed to the tasks of assimilation. As the Chinese currently see it (which is in keeping with international analyses as well), much of the Japanese success in assimilation was due to the attention given to adaptive engineering and R&D in support of absorption, with expenditures on the latter running five to seven times those of the purchase of the technology.[51]

Although China's R&D resources are not insubstantial, they have often been poorly deployed and misused; China's best talent, for instance, is typically employed in centralized research units not physically proximate to the enterprise importing the technology. Furthermore, Chinese R&D personnel have been compartmentalized, keeping researchers and engineers from the academies, the universities, and the production ministries from working together on assimilation tasks.

China has many of the same problems of assimilation that other developing countries receiving transferred technology experience. Yet, China also has both distinctive advantages and disadvantages in dealing with technology from the international economy. During the last 2 years, the Chinese have come to realize the importance of paying special attention to the problems of assimilation. Current discussions of assimilation, however, indicate that the problems that troubled the assimilation process in the past have by no means been overcome. An examination of current assimilation problems points to the following problems.

Technical Manpower

A first constraint facing many developing countries is a shortage of qualified technical and managerial manpower and a lack of scientific tradition. In absolute terms, China has a large pool (approximately 2.4 million) of scientists and engineers.[52] Even though the quality of training received by those in the pool varies a great deal, and the distribution of talent by region and economic sector is unbalanced, China does have a cadre of technical specialists to facilitate technology transfers.

China is also rapidly expanding its technical manpower ranks through its own new educational policies and by taking full advantage of educational and training opportunities offered abroad by institutions of higher education, companies, and foreign governments. Thus, while manpower inadequacies do appear in the context of technology transfers, foreign firms seem to agree that the Chinese are moving up the learning curve effectively.

Manpower limitations affecting the assimilation of foreign technology are exacerbated by two characteristics of the Chinese technical community. The first is the misuse and maldistribution noted above. Too much of China's technical manpower is concentrated in centralized research institutes, which have historically not been well connected to production enterprises. Meanwhile, at the level of the enterprise, there is often a severe shortage of engineers.

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[51] Ibid.

[52] See, Leo A. Orleans, *The Training and Utilization of Scientific and Engineering Manpower in the People's Republic of China*, U.S. House of Representatives, Committee on Science and Technology, October 1983; and Orleans, "Graduates of Chinese Universities: Adjusting the Total," *The China Quarterly* (forthcoming).

Limitations on the mobility of technical personnel also hinder both the assimilation and diffusion of technology. The tendency of enterprises and research institutes to regard technical personnel as the property of the unit has been a major obstacle to labor mobility. A variety of new approaches to stimulate the movement of technical personnel have been introduced since the early 1980s. Although these have had some positive results, the problem remains serious.[53]

Second, problems with the educational system affect the seriousness of the manpower constraint. Two deficiencies in particular stand out. First, the typical Chinese graduate is usually stronger in theory than in hands-on experience relevant to the tasks of technology absorption. Second, the educational system, especially in engineering, has focused too much attention on training narrow specialists who are often ill-equipped to deal with problems requiring interdisciplinary approaches. In addition, the failure of the educational system to produce economists who are familiar with the economics of the industries in which the transfers are occurring is a hindrance to effective decisionmaking.[54]

Management

China's lack of personnel with modern management capabilities may be of greater immediate importance for assimilation than the shortage of scientists and engineers. Although often capable and experienced in working under conditions of static technology and the dictates of a planned economy, China's managers now face a very different environment.

Effective technology assimilation requires a systemic understanding of how the technology will fit into the social system to which it is being transferred and a willingness to take risks and to adopt a timeframe that sees the value of the technology over the longer run. It also requires an understanding of the forward and backward linkages needed for the effective deployment of the technology. As noted above, these are not traits that were instilled in Chinese managers by the old system, which put immediate production targets foremost in the manager's mind and made risk avoidance a rational individual strategy.

The Chinese government is well aware of the limitations of the present enterprise managers. Modernization in management has been encouraged by policy changes such as decentralization of authority, institution of managerial accountability, provision of incentives and flexibility in organizational design. The most effective improvements have resulted from direct contact with modern managerial techniques—through joint ventures and other forms of technology transfer and in training centers, such as the Dalian Institute sponsored by the U.S. Department of Commerce. The number of managers that can benefit directly from such contact is minute compared to the total need in China, but the effect appears to be multiplied by the dissemination of information from the centers and by learning from the example of the now more effective managers. Since managerial inadequacy is one of the most severe constraints, special attention is warrented if technology transfer and China's modernization are to be supported.[55]

Research and Development

In contrast to many developing countries, China has a comprehensive industrial structure and an extensive R&D network. Yet Chinese R&D has had many problems and, like the economy as a whole, is now the target for extensive reforms.[56]

Most sectors of the industrial economy have research, design, and educational institutes.

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[53] See, Leo A. Orleans, "Reforms and Innovations in the Utilization of China's Scientific and Engineering Manpower," paper presented at the conference on *China's New Technological Revolution*, Harvard University, May 9-11, 1986.

[54] Geoffrey Oldham and Alyson Warhurst, "Technology Transfer to the Chinese Offshore Oil Industry," unpublished report, University of Sussex, Science Policy Research Unit, no date, p. 43.

[55] William A. Fischer, "The Transfer of Western Managerial Knowledge to China," app. 5 in vol. II of this report, May 1986.

[56] See, Richard P. Suttmeier, "New Directions in Chinese Science and Technology," in: The Asia Society, *China Briefing: 1985* (Boulder, CO: Westview Press) 1986.

Many of these had experience with technology transfers from the Soviet Union in the 1950s, and all of them have had experience with technological self-reliance since 1960. This R&D system was terribly disrupted during the Cultural Revolution, and its capabilities were reduced. Nevertheless, it is important to recall the evolution of this system since 1949, its many achievements, and the renewed support it enjoys in the post-Mao period. It is a significant resource that could aid China in assimilating foreign technology and avoiding technological dependency. China's technical community needs to be brought up to world levels, but it does not have to be created anew.

Ironically, the existence of an established industrial structure and R&D system at times works against technology transfer. Because domestic industry and the R&D establishment have interests in domestic supply, China is faced with make-or-buy questions that would not trouble other developing countries. In addition, China's domestic industry has had trouble converting the results of its research into serially produced new products. These problems, and the more general relative technological backwardness of the domestic industry, provide opportunities for the foreign suppliers of technology. It is likely, however, that effective international technology transfers will also stimulate the domestic industry to improve its capacity for indigenous innovation.

Like the manpower problem, the R&D system has historically been compartmentalized, and R&D has been concentrated in centralized institutes rather than at the level of the enterprise that needs the technology. The current reforms in China's science and technology management system are intended to change this situation, but it is likely that the strengthening of R&D at the enterprise level will take time.

A second problem is that R&D supportive of technological assimilation has not received priority attention and adequate funding. The linking of R&D plans to technology import plans is a recent development. The new policy emphasis being given to assimilation is intended to bring attention to the need to forge this link, but a lasting solution to the problem is not likely to be found in central policy directives. More likely, the solution will depend on the course of the reforms of the economic and the science and technology systems, with their emphases on enterprise autonomy and the strengthening of enterprise R&D.

The Supply System

China's ability to absorb and assimilate technology is influenced by problems in the domestic economy. Many characteristics of the economy that inhibit domestic innovation in China also affect the assimilation of foreign technology. The inability of the economy to supply high-quality inputs reliably—up to the technical standards required by the foreign technology—to enterprises engaged in the importation and assimilation of technology is one of the more serious of these problems.

One example is the well-publicized case of the Wuhan steel mill, which imported advanced German technology but found that the machinery in which it was embedded could only be used for a fraction of the designed time. The electronic control technology of the imported mill presumed the supply of a reliable source

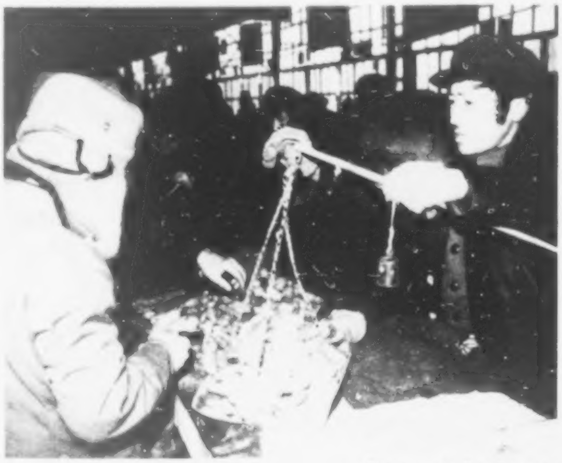

Photo credit: Eric Basques

This ginger root salesman is completing a sale in the Changchun agricultural "free market." Produce in excess of government quotas can be sold for what the market will bear.

of electric power, which the city of Wuhan did not have. In other cases—the Shanghai Foxboro and Beijing-Jeep joint ventures, for instance—the supply problem is also seen in the supply of raw materials, semi-processed materials, and finished intermediate goods.

The uncertain availability of these inputs slows the full assimilation of the technology, prolongs reliance on foreign suppliers, and thus increases the demands for foreign exchange. Scarce supplies have been a particular irritant to joint ventures. In some cases, the best hope is to go to enterprises from the military industries that are now instructed to serve the civilian economy. These enterprises are often able to meet the quality standards required, but they may not have the incentive to link up with the joint ventures. Under current economic conditions and policies, they often find it more profitable and less demanding to produce for the Chinese domestic market.

The response of Chinese enterprises to the uncertainties of the supply system has been to pursue vertical integration, creating a technological system different from those in capitalist countries, in which components for technologies are often sourced from many different supplier companies. This systemic difference influences Chinese choices of technology and assimilation. The Chinese often expect more technology transfer than the Western firm can supply, since some of the component technologies are the property of other firms. The full assimilation of the technology supplied to China may therefore be blocked because the supporting, component technologies are neither available to nor being supplied to China.

Internal Diffusion

The question of how effectively foreign technology is diffused within China remains uncertain. This issue is particularly pertinent for the transfer of dual-use technologies to civilian entities. U.S. national security implications arise if these technologies diffuse to the military. Foreign firms have also been concerned that without effective patent protection, technology licensed to one enterprise may be illicitly transferred to another. China's new patent law and other recent policies designed to encourage technology transfer, should help alleviate some of these concerns. A separate question, however, is the capability of the Chinese system for internal technological diffusion.

Chinese organizations are excessively bureaucratic and compartmentalized. Contrary to the principle of communalism embedded in official ideology, Chinese enterprises and research institutes often act as if they have proprietary claims on technology and, more importantly, on the technical manpower they employ. The clarification of property rights pertaining to knowledge is an important element in current reforms of the science and technology system. Yet the Chinese continue to lament what they refer to as departmentalism, and the lack of effective horizontal, interorganizational communication. Instead, communications follow the strong vertical orientations along which Chinese organizations were designed.

For example, world-class bicycle-manufacturing machinery is produced by the Shanghai Bicycle Co. (SBC), one of China's leading bicycle makers, for its own production. The company has no interest in, nor incentives for, the production and marketing of its manufacturing equipment. The Shanghai Light Industry Bureau had to establish a specialized factory for the production of bicycle-making machinery. While the new plant is able to use the designs and manuals of the SBC's equipment, the personnel from SBC who possess the know-how have not been deeply involved in the diffusion.[57]

The Chinese have attempted to overcome the problems of technological departmentalism by creating mechanisms for crosscutting technological communications. The first of these are the professional societies organized around academic disciplines and industrial technologies. The professional societies draw individuals from different vertical systems (different ministries, academies, and universities) into a common forum. A second mechanism is a network of scientific and technical information services which was developed with the cooperation of the U.S. National Technical Information Service. In addition to these two mechanisms, a large number of technical consulting organizations have been formed in recent years, and other organizations, including production enterprises, universities, and research institutes, have been active in establishing consultancies, as well. Recent policy has also sanctioned consulting by individuals.

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[57] The World Bank, *China: Long-Term Issues and Options: The Main Report* (Washington, DC: 1985), p. 172.

Most importantly, however, the economic reform program is designed to alter the strong vertical, bureaucratic orientations of the economy by creating the conditions for horizontal market exchanges. This is true in the area of technology as well. With the initiation of technology markets for the buying and selling of technology, the regime has, in effect, recognized the de facto proprietary claims to knowledge that had been made by enterprises and research institutes as they resisted the sharing of technology without appropriate compensation. Thus the leadership now encourages the view that technology be considered a commodity to be bought and sold in a market rather than a free public good to be allocated by the state.

The Chinese are also trying to allow greater mobility of technical personnel. To create these conditions, the Chinese have had to modify established practices of administratively assigning technical personnel to jobs and have attempted to establish, on a trial basis, a limited labor market for scientists and engineers.

It is difficult to assess how effective this reform has been, but there are a number of indications that its impact has been dulled by the unwillingness of work units to allow their personnel to leave. Since most social services, including housing, are only available through the work unit, individuals may be reluctant to seek opportunities to move.[58]

The climate for the diffusion of technology has improved markedly in recent years even though the inherited structure of the Chinese economic and research systems still inhibits it. Current Chinese thinking calls for the attraction of foreign technology to the more developed coastal cities and the subsequent diffusion to the interior and throughout the economy. This strategy is becoming increasingly likely to be successful. The problems associated with the power of individual work units to make proprietary claims on technology and technical personnel, however, are formidable.

The Prospects for Assimilation

The financial, manpower, decisionmaking, and economic problems noted above make it likely that assimilation will not go as smoothly as the Chinese and their foreign commercial partners might like. It is important to remember, however, that China also has capacities that make it likely that some of these limitations could be overcome in the relatively near future. These include an expanding pool of trained personnel; an established, extensive R&D system; and new policies to encourage foreign investment and technology transfer, as well as those for economic, administrative, and educational reform. China's leaders, furthermore, have incentives to maintain an environment favorable to technology transfer and absorption.

As these policies have been refined, the importance of the assimilation issue has come into focus. China clearly seeks technology transfer agreements that will facilitate assimilation and include as much of the manufacturing and design know-how, as well as the production technology. Western firms however, have diverse motivations in their dealings with China and in their uses of technology transfer in corporate strategies. The behavior of the supplier of the technology, considered in the following chapters, can also influence China's assimilation ability, thus adding another variable to any analysis of likely assimilation experiences.

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[58] Cf., Orleans. "Reforms and Innovations . . ."

CONCLUSION

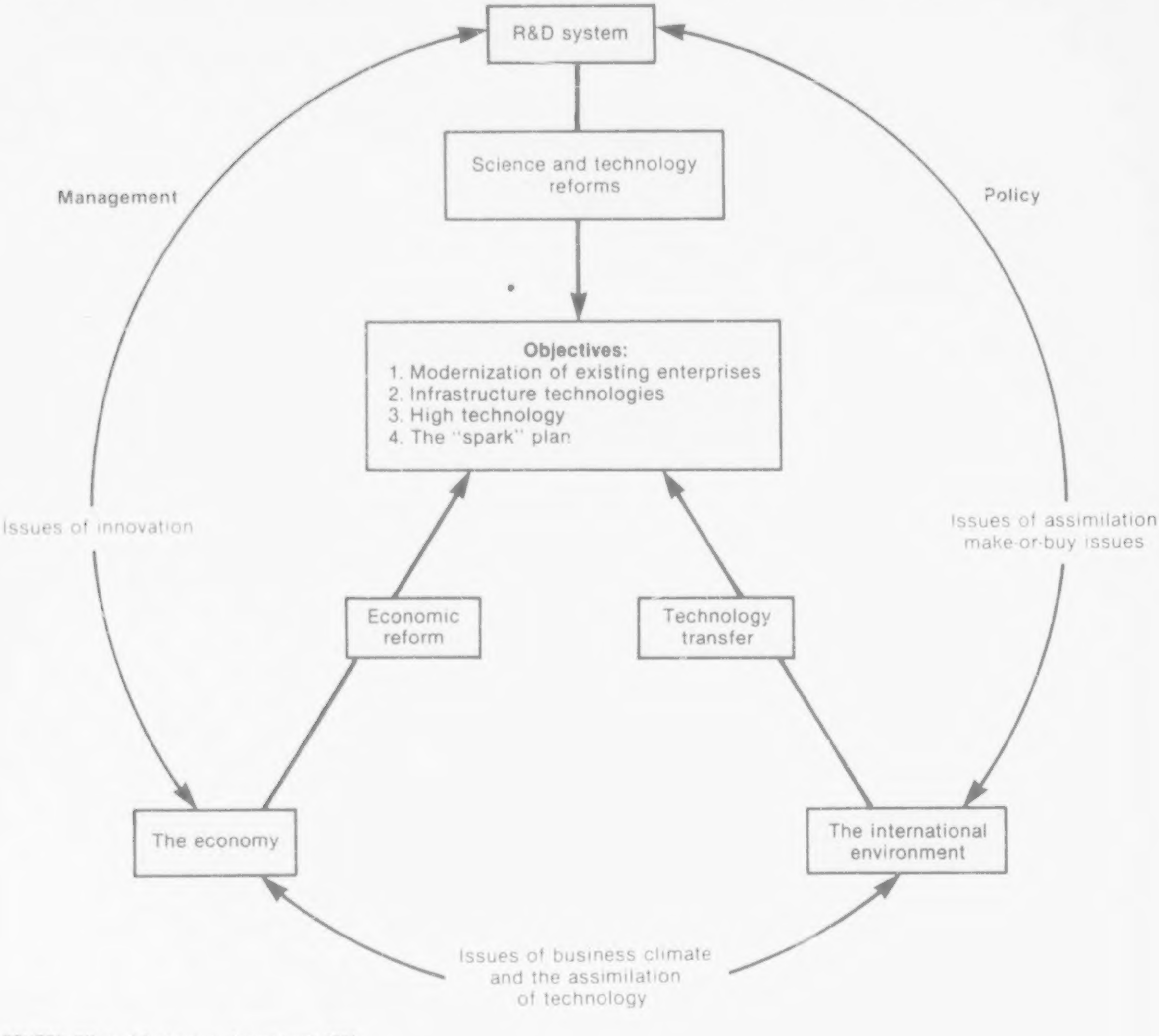
China has ambitious expectations about the role technology will play in its modernization and has set a course both to acquire technology abroad and to increase its domestic capabilities for producing technology. There is much to be said for the course chosen; there are also significant problems of decisionmaking, of assimilation, and with basic economic institutions; problems that must be solved if the full economic value of technology transfer is to be realized. Reforms under way should contribute to the solution of these problems, but the solutions will take time. Cases of China choosing inappropriate technologies and having difficulty with their assimilation are likely to be seen in the future, but they are likely to become fewer.

China's larger quest for modern technical capabilities involves much more than interactions with the foreign suppliers of technology. It is also shaped by the operational objectives of technology policy, by the nature of the domestic economic and R&D systems, by the quality of management, and by the policy environment. The complexity of this context for technology transfer can be seen in figure 3.

As depicted in figure 3, the underlying challenge the Chinese face in creating technical capability is to realize change on a number of fronts simultaneously. An enhanced capability for technological innovation entails changes in both the R&D system and the economy. Economic reform and changes in the policy environment are necessary for improving the climate for foreign investment. Effective absorption of foreign technology requires not only a policy environment conducive to the operation of foreign businesses, but also further economic reform and changes in the domestic R&D system.

While the Chinese realize the significance of the systemic nature of the technology transfer phenomenon, and while their modernization policies are intended to bring the elements of the system into greater harmony, the very complexity of the system makes it likely that there will continue to be problems with technology transfer. The wider significance of these problems is explored in chapter 6.

Figure 3.—The Acquisition of National Technical Capabilities: A Revised View of the Elements Involved


R&D system
Science and technology reforms
Management
Policy
Objectives:
1. Modernization of existing enterprises
2. Infrastructure technologies
3. High technology
4. The "spark" plan
Issues of innovation
Issues of assimilation make-or-buy issues
Economic reform
Technology transfer
The economy
The international environment
Issues of business climate and the assimilation of technology

SOURCE: Office of Technology Assessment, 1987

Chapter 4

The Role of the United States in Technology Transfer to China

Photo credit: Alan T. Crane

Pavilion at the Summer Palace, near Beijing.

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Chapter 4

The Role of the United States in Technology Transfer to China

Although the U.S. Government sets regulations and establishes programs that directly affect technology transfer to China, the actual transfer of technological information and capabilities is generally performed by U.S. companies through direct investment, joint ventures, coproduction agreements, or license agreements. Corporate reasoning by U.S. firms for transferring technology to China includes "getting a foot in the door" of the potentially immense China market, having access to inexpensive labor, and having a presence in the Asian Pacific region for manufacturing, marketing, and distribution.

China's interests in U.S. investment are primarily to improve its technology base and to earn foreign exchange. Foreign exchange derives from various charges to the U.S. firms (taxes, payments for services, labor rates) or through exports of goods created through improved technology. These often divergent interests of the U.S. firms and the Chinese can be the basis for mutually beneficial relationships —or a great deal of friction. The case studies in this chapter illustrate how well the U.S.-China relationship works in actual practice.

FACTORS AFFECTING U.S. COMPANIES IN THE CHINA MARKET

When the Chinese market opened to Western business in the late 1970s, foreign companies were elated. China was a country needing almost everything. It had a huge supply of potential customers and inexpensive workers, and was ruled by an apparently honest and dedicated new (albeit Communist) leadership. The economies of the United States and China were also often viewed as complementary. It was hoped that American high-technology products, capital goods, and industrial materials would help China's development, while the United States would be a growing market for Chinese goods.

In fact, in 1985 the United States accounted for about 10 percent of China's imports and 12 percent of China's exports.[1] The United States ranked as China's third-largest trading partner after Japan and Hong Kong,[2] while China moved up three places to 16th among U.S. trading partners. Table 2 lists Department of Commerce statistics on the composition of U.S. exports to China from 1980 to 1986. Machinery and transport equipment was a major U.S. strength, accounting for almost $2 billion in sales to China in 1985 and over $1 billion in the first half of 1986.

Table 3 lists statistics for U.S. imports from China for 1980-86. Most U.S. imports in this table are in the category of "miscellaneous manufactured articles" (which includes articles of apparel and clothing accessories), representing almost $1.2 billion of trade in just the first half of 1986. Basic manufactures (mostly textiles, yarn, and fabrics) and crude materials (mostly petroleum and petroleum products) also represent significant imports by the United States.

China's Seventh Five-Year Plan (1986-90) envisions a 40-percent increase in the total volume of China's imports and exports by 1990, with the Chinese projecting imports growing

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[1] Nai-Ruenn Chen, "U.S.-China Trade Patterns: The Outlook for Two Countries With a Lot to Share," *The China Business Review*, September-October 1986, pp. 16-20.

[2] Japan had a 28.3 percent market share of China's imports in 1986, Hong Kong 12.7 percent, and the United States 10.2 percent (U.S. Department of Commerce, February 1987).

Table 2.—Commodity Composition of U.S. Exports to China, 1980-86 (million dollars)

	1980	1981	1982	1983	1984	1985	Jan June 1986
Foodstuffs	**1,265**	**1,334**	**1,239**	**541**	**580**	**104**	**16**
Cereal and cereal preparations	1,264	1,332	1,236	536	578	97	6
Crude materials	**1,258**	**1,128**	**597**	**298**	**467**	**570**	**224**
Hides, skins, and furskins, raw	13	7	11	4	22	30	12
Oil-seeds and oleaginous fruit	156	130	63	0	[a]	13	19
Crude rubber (including synthetic and reclaimed)	5	5	3	5	9	9	9
Cork and wood	41	99	217	234	287	328	123
Pulp and waste paper	67	69	18	21	18	19	10
Textile fibers and their waste	895	791	273	31	99	122	25
Metalliferous ores and metal scrap	5	[a]	[a]	[a]	21	43	16
Animal oils and fats	16	2	6	0	0	0	[a]
Fixed vegetable oils and fats	58	20	0	0	7	[a]	0
Chemicals	**381**	**406**	**496**	**353**	**644**	**514**	**197**
Organic chemicals	40	44	38	25	71	87	39
Inorganic chemicals	22	6	9	20	20	12	16
Fertilizers, manufactured	153	131	147	168	267	152	18
Artificial resins and plastic materials	120	170	237	92	234	228	109
Chemical materials and products	46	53	61	46	46	28	9
Basic manufactures	**428**	**447**	**275**	**220**	**189**	**370**	**91**
Leather, leather manufactures, n.e.s., and dressed furskins	49	64	65	26	39	63	13
Paper, paperboard, and articles	130	61	36	41	32	27	11
Textile, yarn, fabrics, made-up articles, and related products	134	284	128	17	46	141	42
Iron and steel	42	8	10	7	4	12	7
Nonferrous metals	24	10	23	94	34	54	3
Manufactures of metals, n.e.s.	42	20	7	31	29	67	10
Machinery and transport equipment	**358**	**212**	**217**	**587**	**910**	**1,958**	**1,070**
Power generating machinery and equipment	14	11	8	56	29	88	54
Machinery specialized for particular industries	63	67	71	89	196	482	201
Metal-working machinery	7	4	3	25	23	55	60
General industrial machinery and equipment, n.e.s. and machine parts n.e.s.	35	34	34	47	61	153	83
Office machines and automatic data processing equipment	31	22	36	51	102	190	98
Telecommunications and sound recording and reproducing apparatus and equipment	8	16	12	18	26	44	32
Electrical machinery, aparatus and appliances, n.e.s. and electrical parts, thereof	18	21	25	43	53	101	67
Road vehicles	18	7	9	22	63	99	65
Other transport equipment	164	29	19	236	356	745	409
Miscellaneous manufactured articles	**56**	**71**	**78**	**166**	**202**	**319**	**166**
Professional, scientific, and controlling instruments and apparatus, n.e.s.	46	55	65	145	182	282	129
Photographic apparatus, equipment and supplies, and optical goods, n.e.s., watches and clocks	2	5	4	5	4	8	5
Miscellaneous manufactured articles, n.e.s.	6	8	8	16	12	27	28
Total	3,746	3,598	2,902	2,165	2,992	3,835	1,764

[a] Less than $500,000

n.e.s.—not elsewhere specified

SOURCE: U.S. Department of Commerce statistics. SITC classifications.

Table 3.—Commodity Composition of U.S. Imports From China, 1980-86 (million dollars)

	1980	1981	1982	1983	1984	1985	Jan.-June 1986
Foodstuffs	**65**	**108**	**135**	**129**	**162**	**182**	**109**
Fish, crustaceans and mollusks, and preparations, thereof	7	25	19	12	21	32	35
Cereal and cereal preparations	3	4	4	5	5	6	3
Vegetables and fruit	25	44	59	58	77	75	33
Sugar, sugar preparations, and honey	8	9	8	9	6	8	8
Coffee, tea, cocoa, spices, and manufactures, thereof	15	19	37	34	40	47	23
Beverages	2	2	3	5	5	4	5
Crude materials	**300**	**657**	**774**	**589**	**794**	**1,204**	**524**
Crude fertilizers and crude minerals	41	53	60	47	57	53	17
Metalliferous ores and metal scrap	37	52	25	11	17	32	17
Crude animal and vegetable materials, n.e.s.	56	49	42	35	39	41	
Petroleum, petroleum products, and related materials	149	321	615	468	656	1,052	457
Chemicals	**107**	**134**	**143**	**145**	**171**	**177**	**100**
Organic chemicals	16	26	26	34	45	36	23
Inorganic chemicals	33	39	38	17	33	41	17
Medicine and pharmaceutical products	10	20	20	26	23	28	13
Essential oil and perfume materials, toilet, polishing, and cleaning preparations	14	11	14	16	16	15	8
Explosives and pyrotechnical products	26	28	36	33	35	42	30
Chemical materials and products, n.e.s.	8	9	8	13	10	10	5
Basic manufactures	**246**	**394**	**407**	**425**	**607**	**665**	**357**
Leather, leather manufactures, n.e.s., and dressed furskins	1	3	2	3	6	3	2
Cork and wood manufactures (excluding furniture)	5	6	6	8	8	10	4
Paper, paperboard, and articles of paper pulp, of paper or of paperboard	2	3	3	3	4	11	3
Textile, yarn, fabrics, made-up articles, and related products	149	252	239	255	392	399	251
Nonmetallic mineral manufactures, n.e.s.	19	33	40	50	65	59	31
Iron and steel	[a]	6	7	3	3	3	5
Nonferrous metals	44	44	45	31	35	80	18
Manufactures of metals, n.e.s.	26	46	63	73	91	97	42
Machinery and transport equipment	**6**	**44**	**48**	**46**	**71**	**97**	**52**
Machinery specialized for particular industries	[a]	[a]	5	6	7	7	3
Metal-working machinery	1	4	5	5	4	3	2
General industrial machinery and equipment, n.e.s. and machine parts n.e.s.	2	30	20	14	16	14	7
Telecommunications and sound recording and reproducing apparatus and equipment	[a]	4	6	10	29	36	16
Electrical machinery, apparatus and appliances, n.e.s. and electrical parts, thereof	2	3	5	3	8	20	15
Miscellaneous manufactured articles	**417**	**650**	**916**	**1,133**	**1,552**	**1,855**	**1,197**
Furniture and parts thereof	10	19	29	34	38	44	23
Travel goods, handbags, and similar containers	3	16	30	45	101	154	90
Articles of apparel and clothing accessories	278	434	657	840	999	1,050	768
Footwear	21	37	42	38	48	61	41
Miscellaneous manufactured articles, n.e.s.	103	140	154	169	355	532	267
Total	**1,141**	**1,987**	**2,423**	**2,467**	**3,357**	**4,180**	**2,339**

[a] Less than $500,000.
n.e.s.—not elsewhere specified.

SOURCE: U.S. Department of Commerce statistics, SITC classifications.

at an average annual rate of 6.1 percent and exports at 8.1 percent annually. Recent figures indicate that U.S.-China trade reached $8.3 billion in 1986, a 33-percent increase over 1985 levels.[3] The growth in this bilateral trade was import driven, however, with U.S. imports from China setting a record at $5.2 billion, a 24-percent increase over 1985. U.S. exports totalled $3.1 billion for 1986, a 19-percent drop from 1985 levels, the first decrease since 1983. The U.S. trade deficit with China reached an historic high of $2.1 billion in 1986, primarily due to China's hard currency shortage and the boom in U.S. imports in the light industrial sector and in clothing, textiles, yarns, and fabrics.[4]

Future trade between the United States and China should come into closer balance. The potential is there since the United States holds a strong competitive position in the energy, telecommunications, electronics, and transportation sectors—all priority areas in the Chinese Seventh Five-Year Plan. For example, despite the drop in total exports from the United States to China in 1986 compared with the previous year, some big gainers for the United States were exports of high technology, such as computers and telecommunications equipment, as well as metalworking equipment (which more than doubled the previous year's level), heating and cooling equipment, and railway vehicles and equipment.[5]

The U.S. sales to China described above have been significant and probably will continue to be. China is more interested in investments than direct sales because they promote technology transfer. However, after rushing in with many business proposals when China initiated its open door policy, few U.S. businesses have seen their overtures come to profitable fruition. Many U.S. firms feel that the bloom is off the rose. Indeed China's investment climate, many foreign businessmen say, has steadily deteriorated at least until recently. They complain of soaring costs, arbitrary tax and tariff levies, inadequate labor, and numerous other annoyances.[6] As U.S. Ambassador to China Winston Lord said in a May 28, 1986, speech, "Many business people are frustrated by high costs, price gouging, tight foreign-exchange controls, limited access to the Chinese market, bureaucratic foot-dragging, lack of qualified local personnel, and unpredictability." Some U.S. companies are making money in China, but they are reluctant to talk about it for competitive reasons. This is partly due to not wanting to let their competition know of a good opportunity, and partly because they fear the Chinese would feel justified in raising their taxes and other local costs.

The Investment Environment

Foreign investment in China from January 1986 to August 1986 fell by 20 percent (to contracts worth $1.24 billion) compared with the same period in 1985, confirming perceptions that the investment climate had been deteriorating. Less than one-third of the 2,600 joint venture companies listed so far have actually gone into business. Of the remainder, many have been scaled down or dropped completely owing to high costs, unfavorable returns, and management problems.[7]

A fundamental problem with joint venture arrangements, according to foreign businessmen, is that the foreign partner usually contributes foreign exchange and technology, while the Chinese contribute property, equipment, and services (such as electricity and water) on which they place an unrealistically high value. The Chinese have recently stated that they will try to remedy this situation. A correlative problem is that the Chinese tend to undervalue the technology contributed by the foreign investor.[8] Trying to find a solution to this basic problem is critical and is much more difficult than solving the problem of overvalued Chinese properties or services.

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[3] U.S. Department of Commerce data, February 1987.

[4] Japan had a $4.9 billion trade surplus with China and Hong Kong a $3.6 billion surplus in 1986.

[5] U.S. Department of Commerce, February 1987.

[6] James P. Sterba, "Great Wall—Firms Doing Business in China Are Stymied by Costs and Hassles—They Complain of Red Tape, Poor Access to Markets, Even a Shortage of Labor," *The Wall Street Journal*, July 17, 1986, p. 1.

[7] "Joint-Venture Bliss Ends in China," *The Economist* of London appearing in *The Washington Times*, Aug. 20, 1986, p. 3D.

[8] See, for example, Cao Yan, "Analysis on 'Free' Technology Imports," *JISHU SHICHANG BAO* (Tianjin), Oct 7, 1986, p. 3.

In an effort to improve the investment climate, the Chinese Government adopted "The Law of the People's Republic of China on Enterprises Operated Exclusively with Foreign Capital" in 1986. This law stipulates that companies that bring in advanced technology or export the bulk of their production, can establish wholly foreign-owned enterprises in China.[9] These enterprises may also apply for preferential tax treatment. Once approved by the Government, these ventures will also be protected under Chinese law from nationalization and expropriation, except under "extraordinary circumstances;" and if such action is necessary, "legal procedures will be followed and reasonable compensation will be made."[10]

It is expected that foreign exchange receipts will balance any foreign exchange payments. Income tax refunds will be granted when after-tax profits are reinvested in China, but legitimate profits may be remitted abroad.[11] The definition of what constitutes a legitimate profit is, however, still not clear.

It was recently announced that the Bank of China is going to relax its tight credit policies to give loan priority to enterprises that involve foreign investment. The bank will, in particular, extend help to technology-intensive companies and manufacturers of products for export. Wong Deyan, the bank's president, said that the central bank will amend regulations on the issue of credit for enterprises with foreign funds in a bid to create better conditions for their development.[12]

Foreign businessmen reacted cautiously to these statements of relaxed policies, however, since they do not work toward resolving day-to-day management problems of wages, hiring, training, and others that are also serious. The joint ventures are struggling toward different solutions to these fundamental problems.[13]

The latest attempt by the Chinese to improve the investment climate came in the 22 articles listed under "Provisions of the State Council of the People's Republic of China for the Encouragement of Foreign Investment," listed in Appendix A. The intent is "to improve the investment environment, facilitate the absorption of foreign investment, introduce advanced technology, improve product quality, expand exports in order to generate foreign exchange and develop the national economy." The articles spell out various conditions and fees applied to foreign ventures to reduce the uncertainty involved. These new regulations benefit mostly export-oriented and high-technology firms but fall short of meeting some basic investor concerns.[14] Foreign executives were cautious at first, taking a "wait and see" attitude toward the new regulations,[15] but recently, renewed interest in certain joint ventures has been evident.[16]

Schedule Delays, Taxes, Other Costs

Foreign firms in China have complained that the Chinese do not seem to understand that time is money. An example is the McDonnell Douglas venture (covered later in this chapter), which took 10 years to finalize. Eventually McDonnell Douglas won a contract for 30 MD-82s, with a price averaging out to about $25 million per plane. Five have been delivered and are in operation. Twenty-five more will be built in Shanghai.

McDonnell Douglas persevered because it hopes to be involved in the development of a 100-passenger propfan aircraft to be built in

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[9] "Foreign Investor Ruling," *China Business and Trade*, Apr. 23, 1986, p. 3. The regulations themselves appeared in *China Daily*, Apr. 15, 1986. It should be noted, however, that just because an enterprise is wholly foreign-owned does not mean that it will be free of the problems described previously.

[10] "Foreign Investor Ruling," op. cit.

[11] Ibid.

[12] "China to Ease Credit for Joint Ventures," *Financial Times*, Aug. 8, 1986, p. 4.

[13] "Joint-Venture Bliss Ends in China," op. cit.

[14] U.S. Department of Commerce, February 1987.

[15] James R. Schiffman, "Foreign Executives Wary of China's Pledge to Investors," *The Wall Street Journal*, Aug. 11, 1986.

[16] Roger W. Sullivan, "The Investment Climate," *The China Business Review*, January-February 1987, pp. 8-10. See also Barry Kramer, "Beijing's Course: The Chinese Economy Appears to be Firmly on the Reform Path—But the Pace of Change Slows After Resignation of Hu: Political Reforms on Hold," *The Wall Street Journal*, May 14, 1987, p. 1.

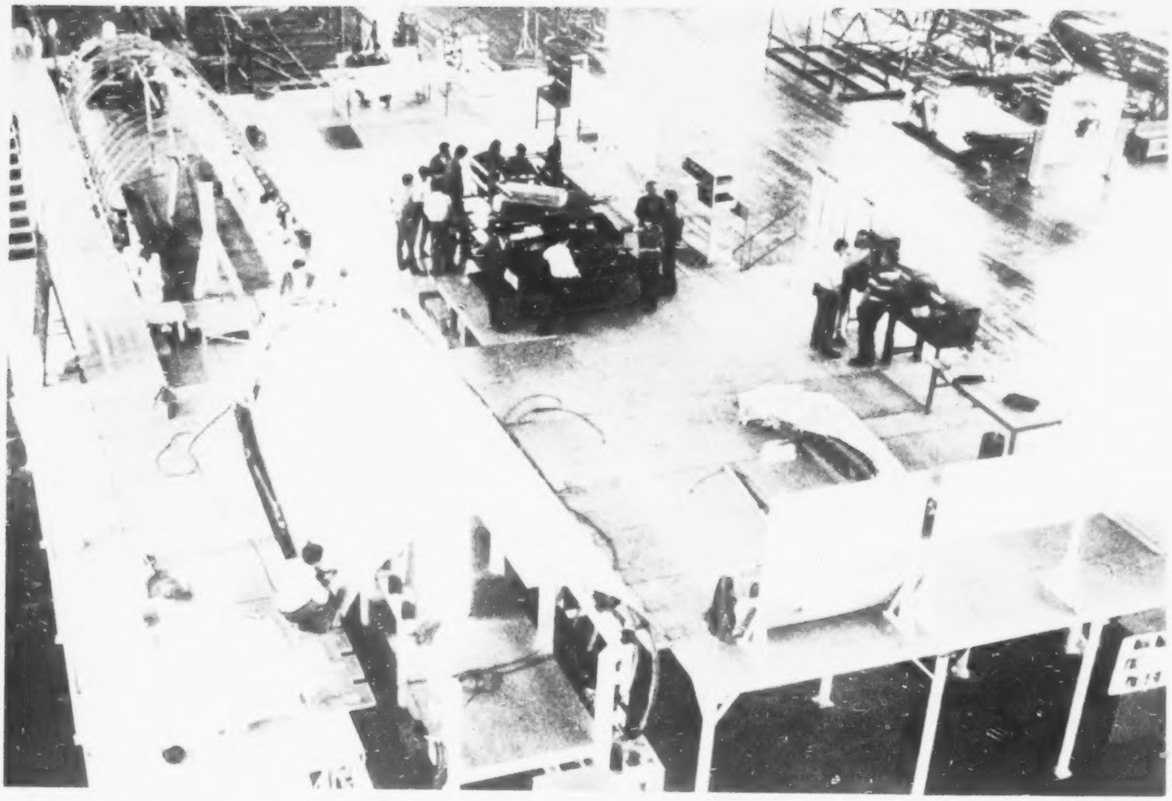

Photo credit: McDonnell Douglas

Portions of a McDonnell Douglas MD-82 fuselage are shown being assembled at Shanghai Aviation Industrial Corp. facilities. Part of the coproduction contract involves extension of Douglas' Federal Aviation Administration production certificate to the Shanghai facility.

China.[17] The potential market is 500 to 1000 planes over a period of more than 10 years. Thus the McDonnell Douglas effort is measured in a few decades, not a few years. McDonnell Douglas hopes that its patience and long-term view in the China market will be rewarded.

As another example, U.S. companies competing for China's proposed purchase of satellites spent large sums of money and devoted much company time to pursue what promised to be both a very substantial sale and a chance to establish a firm lodging in a promising market.[18] When the two proposed purchases were "postponed," these companies were disenchanted with the Chinese market and might refrain from bidding if the opportunity arises again.[19]

The satellite postponement story is not atypical. European nuclear companies had once estimated the nuclear technology market in

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[17] "First Chinese-Assembled MD-82 Nears Completion in SAIC [Shanghai Aviation Industrial Corp.] Facilities," *Aviation Week and Space Technology*, June 1, 1987, pp. 34-35.

[18] Hughes was estimated to have spent $500,000 on the 1979-80 projected sale alone. GE expenditures were estimated at $300,000. See Karen Berney, *CBR*, March-April, 1981. RCA-Astroelectronics (now called GE Aerospace-Astrospace Division) reportedly spent over $1 million in courting the Chinese satellite contracts.

[19] These types of problems occur in countries other than China too, of course. For example, Argentina has been negotiating for several years for the purchase of satellites from a U.S. firm. Bureaucratic infighting and the country's financial problems have kept Argentine officials from making a decision.

China to be worth up to $20 billion.[20] [21] However, in the past months, the Chinese Government has scaled down ambitious plans for 10 nuclear power stations by the end of the century. The only firm plan for an imported plant is the 1,800-megawatt Daya Bay plant near Hong Kong, for which Framatome of France, Electricite de France, and General Electric Co. of Britain have contracts to supply equipment and assistance totaling $1.7 billion. All other plans have been postponed indefinitely, to the frustration of Framatome and Kraftwerk Union of West Germany, which had spent several years negotiating with the Chinese.[22]

By its nature, international business is risky, and overall, China is probably no riskier than other countries.[23] However, businessmen expect a profit commensurate with the risk, and many companies have found little or no profit in their China business. Especially in very competitive areas, such as nuclear power, China has been able to play companies and countries off against one another to get very low-cost contracts. China maintains that companies should accept a low profit margin in recognition of the potential size of the Chinese market. Some companies such as General Electric (GE) accept this approach, hoping to gain a foothold and do well over the long haul. It is not yet clear how many companies will benefit from this strategy, but many U.S. companies are likely to lack the patience even to try. As has often been noted, American companies tend to focus on opportunities offering quick profits, in contrast to Japanese companies, which are prepared to wait.

Since adopting the open door policy, China has drawn up a multitude of preferential tax laws to woo foreign investors.[24] These include the "Corporate Income Tax Law for Chinese-Foreign Joint Ventures" of 1980, and the 1981 "Income Tax Law for Foreign Enterprises." As for investments in Special Economic Zones (SEZs), the "Special Economic Zones Regulations for Guangdong Province" of 1980 stipulates a preferential income tax rate.

All of these tax laws provide tax reduction or exemption for projects that require a large amount of capital, involve sophisticated technology, or are located in remote areas. Moreover, companies that invest in opened, coastal cities or opened points in several deltas are offered preferential treatment to various degrees. Furthermore, to speed up port development, China has announced that projects in port development will be exempt from taxes for 1 to 5 years, and will enjoy a 50-percent reduction in taxes from the 6th through the 10th year. Imported construction materials and equipment are exempt from customs and the industrial and commercial unified tax. All of these SEZs, the 14 open cities, and the economic development areas like Liaodong Peninsula have an array of special incentives for foreign investment and for the importation of technology for the establishment of new enterprises and the rehabilitation of existing plants.

Despite these tax breaks and tax exemptions, however, foreign businessmen feel that they are being taken advantage of. For many foreign businessmen who have been involved in trade with China over the past few years, doing business in China has not gone as well or been as profitable as they had hoped. One reason for this, they say, is that the tax burden of an investor is not limited to the income taxes listed above. The total burden also includes corporate income tax, local income tax, commerce and industry tax, residence tax, personal income tax,[25] and tax on bonuses paid to Chinese workers.

Apart from taxes, people who do business in China must also pay several types of charges and fines, including local or unit levies, which businessmen say are often capricious.

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[20] Robert Thompson, "Chinese Studying Nuclear Technology," *Toronto Globe and Mail*, May 7, 1986, p. B-23.

[21] U.S. Congress, Office of Technology Assessment, *Energy Technology Transfer to China, A Technical Memorandum* (OTA-TM-ISC-30, Washington, DC: U.S. Government Printing Office, September 1985).

[22] Thompson, op. cit.

[23] See for example, Jackson Diehl, "East Bloc Ventures Face Uncertainties: Currency, Market Issues Plague Joint Efforts with Western Firms," *The Washington Post*, Mar. 1, 1987, p. H3.

[24] "Why Foreign Businessmen Feel They Are Being Milked," JPRS, Feb. 20, 1986, pp. 48-51, article by Yuan Liu, "The Hidden Burdens of Doing Business in China," *Chiu Shih Nien Tai* [The Nineties] in Chinese, No. 12, Dec. 1, 1985, Hong Kong, pp. 64-65.

[25] Personal income tax is payable by an individual who has been in China for more than 90 days. The incidence of tax is affected by the U.S.-Chinese treaty on double taxation.

A joint venture or a foreign enterprise is responsible for all its workers' wages, allowances, and the social security the state provides the workers when they become sick, grow old, or die. One joint venture for a major hotel in Guangzhou paid wages, bonuses, diligence awards, allowances for dependents, social security, state subsidies, medical expenses, retirement, accident compensation, and food.[26] Besides these wages and allowances, regulations also provide for legal holidays, official holidays, annual leave, sick leave, leave for visiting relatives, maternity leave, and wedding leave. Thus, to run an enterprise in China, the foreign investor has to pay several times the nominal wage rate in addition to numerous taxes and fees. The high rates and many charges for joint ventures are meant to maximize short-run foreign exchange earnings.

Intellectual Property

Almost as soon as China opened its doors to Western technology, U.S. companies became concerned about the lack of legal protection for much of their proprietary technology. In certain cases it was reported that advanced technology would not be transferred to China until there was some form of patent and licensing protection. The Chinese Government, on the other hand, did not want to be stymied by what it considered unfair restrictions on indigenous technology development. Realizing the importance placed by foreign companies on legal protection, Chinese Government officials, after several years of internal discussion, formulated the first Chinese Patent Law, which went into effect on April 1, 1985.[27] Departments are now formulating detailed rules and training patent agents. The special features of the new patent law, according to the Chinese, are that "it absorbs the spirit of patent policies in other countries and allows for China's actual conditions and international practice. Its aim is to encourage and popularize inventions and speed up scientific and technological development and the modernization drive."[28]

The Trademark Office of the State Administration of Industry and Commerce is responsible for the registration and control of trademarks throughout China. For certain classes of goods, the Trademark Office may prescribe that they should bear a trademark. In this case, no goods within that classification may be sold unless they carry a registered trademark. At present, this applies for all pharmaceutical goods.

The value of the patent and trademark measures in protecting foreign companies has not yet been tested in the courts. Several commentators have expressed skepticism on their protection value.[29] For example, China's patent law fails to provide protection for pharmaceuticals, chemical formulas, or trade secrets. There is no copyright regime to protect published works, computer software, or semiconductor designs. It would also be very difficult for a company to find out if its patent were being violated because of the lack of access to most of the Chinese market.

Local Sourcing, Employment, Export Marketing

Manufacturing facilities must generally obtain many parts, supplies, and services locally to operate efficiently, but in China the quantity and quality of local content is a major problem. This is especially evident in the Beijing Jeep joint venture of American Motors Corp. (AMC), discussed below. The Chinese have ambitious goals for developing a supplier base for the jeep. Domestic content in the jeeps is currently in the range of 10 to 15 percent, but about 75 percent is needed for profitable exports.[30] The Chinese went into this venture

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[26] "Why Foreign Businessmen Feel They Are Being Milked," op. cit.

[27] For a detailed discussion on intellectual property issues in China see Tek Ling Chwang and Richard L. Thurston, "Technology Takes Command: The Policy of The People's Republic of China with Respect to Technology Transfer and Protection of Intellectual Property," *The International Lawyer*, vol. 21, No. 1, Winter 1987, pp. 129-167.

[28] *The China Daily*, "Legal Advisor: Your Patent Queries Answered," Feb. 4, 1986, p. 4.

[29] Nigel Campbell, *China Strategies—The Inside Story*, University of Manchester/University of Hong Kong, 1986, p. 115.

[30] Richard Johnson, "AMC, Chinese Move to Save the Beijing Jeep," *Automotive News*, June 2, 1986, p. 6.

Photo credit: General Electric

Contract negotiations can be cumbersome. The lone GE representative faces whole teams of Chinese in talks leading to the first contract for locomotives.

wanting technology as well as the potential for exports, and thus would like to achieve domestic content of 80 to 90 percent in 5 to 7 years. AMC, however, says this goal cannot be achieved without strong backing from the Chinese Government.

One aspect of dealing in China that is difficult for foreign investors to fathom is that labor shortages can exist in a country with over one billion people. Yet, Chinese bureaucracy has created labor shortages. Foreign companies cannot simply advertise for a needed worker, such as a secretary or an engineer. Instead, they must go through the Foreign Enterprises Service Corp. (FESCO), which monopolizes Chinese workers and assigns them to foreign companies.[31] The workers are politically screened and trained to keep a watch on the foreign business.[32] Since FESCO cannot meet the demand for workers, the waiting lists are long, and the foreign firms must make do with whoever is finally assigned to them. FESCO can also pull away workers at any time.

In keeping with China's desire to make as much foreign exchange as it can from labor charges, wages set by FESCO are higher than those in most Asian economies. The worker does not draw this wage—as much as 85 percent of it, as well as most of any incentive bonuses, goes back to FESCO. The U.S. Embassy cites an extreme case in which a French oil company reportedly paid $9,000 a month for a highly trained technician. The technician's monthly take-home pay, however, was $54.[33]

Foreign firms may be allowed to bring in expatriate staff, but that is also expensive. Beijing is already among the costliest places in the world in which to maintain expatriate staff: $150,000 to $200,000 per year.[34] This does not include office rent, which ranges from $50,000 a year at the not very luxurious Beijing Hotel to $125,000 at the Great Wall Hotel.[35]

Lack of labor mobility can also cause difficulties. Getting specialized staff can be a problem because other companies are reluctant to lose their best workers and often prevent their leaving. Official reports show that 4,000 of Shanghai's skilled workers recently asked for transfers to more suitable jobs, but fewer than 350 of them were actually transferred.[36] At the Shenda Telephone Co., a joint venture between Cable and Wireless (U.K.) and its Chinese partners in Shenzhen (a special economic zone on the border of Hong Kong), Cable and Wireless decided to pay for the education of three potential employees under a Ministry of Education program. "Buying" staff in this way means extra cost and delays but enables the foreign company to plan ahead.[37]

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[31] Sterba, op. cit.

[32] Employees for joint ventures are often recruited through local labor bureaus which are not the same as FESCO, which is a Beijing entity. Thus, they may not be quite so indoctrinated.

[33] James P. Sterba, "Great Wall—Firms Doing Business in China . . . " This assertion about the technician's pay has been disputed by a Chinese official in a letter to the *Wall Street Journal.*

[34] Andrew Ness, "Price Hikes and the Foreign Business Community," *The China Business Review,* March-April 1986, p. 52.

[35] Rents for office space in Beijing's four joint venture hotels now average $11.80 per square foot per month according to a March 1986 report by the U.S. Embassy in Beijing. This makes space in Beijing much more costly than the equivalent space in Hong Kong Central.

Foreign Exchange Concerns

Foreign exchange concerns permeate every deal in China. For example, the Beijing Jeep Corp., Ltd. (BJC) was recently in a crisis, due primarily to foreign exchange problems. The 3-year-old joint venture began to assemble Cherokee Jeep kits in the fall of 1985. New Chinese Government restraints on using convertible currency quickly undermined production plans, however. AMC received a license for importing Cherokee kits, but shipment was held up because of monetary disputes. Delays in dollar-based payments for these complete-knockdown (CKD) kits (unassembled parts) resulted in a 2-month suspension of production in mid-1986. The impasse on the kits ended when AMC agreed to accelerate local content in Beijing-built Cherokees in return for dollar-denominated (hence potentially more easily repatriated) payments by the Chinese for North American-sourced knockdowns.[38]

Management Styles, Training, Language, and Cultural Considerations

It has been suggested that a useful characterization of the typical Chinese manager is that of a technically trained, operationally experienced individual whose career and professional skill development have evolved during a period of limited or no market interaction, strict prohibitions against organizational diversification, and limited economic rationality (as we know it in the West) regarding performance evaluation and reward.[39] One of the significant consequences of this situation is a widespread lack of many of the specific functional management skills commonly associated with the concept of modern management. Many of these apparent management skill deficiencies in Chinese managers are identified in table 4. In a more general management context, the average Chinese manager perceives his role as being more of an information conduit from the top of the economic hierarchy

Table 4.—A Sample of Functional Management Knowledge Apparently Lacking in the Chinese Management Community

Marketing:
  - Market research
  - Advertising
  - Product design
  - Industrial marketing
  - Consumer marketing

Manufacturing:
  - Total quality control
  - Managing high-volume/high-variety operations
  - Value analysis
  - Inventory management
  - Manufacturing information systems
  - Distribution systems

Ethics and comparative management

Contract law

Human resources:
  - Motivation and incentives
  - The concept of directorship
  - The role of the manager
  - Executive compensation
  - Organizational design
  - Leadership styles

Finance:
  - Investment analysis
  - Methods of financing
  - International finance

Accounting:
  - Establishment of control systems
  - Auditing
  - Public accounting

Management of science and technology:
  - Anticipating technological change
  - Managing innovation and creative groups

SOURCE: Office of Technology Assessment, 1987 to the workers below than a decisionmaker/ risktaker.

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[36] "Shanghai—The Ugly Daughter Repents," *The Economist*, Aug. 9, 1986, pp. 27-28.

[37] "Joint-Venture Bliss Ends in China," op. cit.

[38] Johnson, op. cit.

[39] Appendix 5, Vol. II, "The Transfer of Western Managerial Knowledge to China," by William A. Fischer, May 1986.

The coproduction of MD-82s in China by McDonnell Douglas (described below) demonstrates the management challenges that can occur when starting a venture.[40] The challenges included the need to bridge cultural gaps and to meet the rigors of budget restraints and regulatory requirements.[41] Budget pressure was imposed because the project was commercial and not a military coproduction program. Regulatory requirements were imposed to assure that U.S. Federal Aviation Administration (FAA) certification standards were preserved during manufacturing.

Management difficulties arose in the McDonnell Douglas joint venture for several reasons.[42] These included:

- Trying to introduce untrained Chinese workers to the "grid" system of management used by McDonnell Douglas, a system that holds that information and authority flow in different directions depending on the problem to be solved. This system is different from the Maoist "struggle sessions" that replaced productive work during China's Cultural Revolution (although in theory Maoist objectives could be compatible with this system).
- Because of the complexity and quality control requirements of aircraft manufacture, McDonnell Douglas U.S. operations have developed over 600 inhouse manuals of standard procedures (of which only-200 have been translated into Chinese so far). These procedures sometimes go against the Chinese way of doing things. In addition, some Chinese are now frightened of doing anything that is not laid down in the procedures, which leads to decisions being made slowly.

  The usual arguments in Chinese joint ventures over quality were eliminated once the Chinese realized that approval for the finished aircraft from the FAA hinged on meeting explicit, stringent standards.
- Thousands of manufacturing drawings and pages of technical literature had to be translated into Chinese.

Another management concern has been training, which has turned out to be very difficult. Chinese engineers have educational backgrounds and work habits very different from those of their U.S. counterparts. The Chinese tend to be specialists, whereas the Americans are more generalists. The high standards demanded by the MD-82 manufacture had to be made quite clear to the Chinese. To help meld the two groups, 150 Chinese employees are being trained at Long Beach, California, for management positions in the program. About 30-40 senior McDonnell Douglas people are onsite at Shanghai as advisors and comanagers to their Chinese counterparts; this group will eventually grow to about 100. About 1,000 people are employed on the MD-82 program at present, and the peak is expected to be 3,000.

Other, less tangible, management problems must also be faced. Philosophically, the Chinese place much emphasis on human values, whereas the Americans are concerned about productivity and "the bottom line." Managers must learn to emphasize both. Neither American nor Chinese managers have been prepared for the differences in the concepts of trust and respect.[43]

Comparative Investment Environments

To appreciate more fully the nature of the Chinese investment environment, it is appropriate to examine its main features from a comparative perspective. In most categories, especially in business facilitation, China's investment climate stands in sharp contrast to the existing situation in places such as South Korea, Taiwan, Singapore, and Hong Kong, all of which have developed very specialized and focused organizations to promote, process, and administer foreign investment projects. In Taiwan, for example, an "industrial development and investment center" was created to link the island's development needs with the interests of potential foreign investors. Because of the strategic role attached to foreign investment, special consideration was given to addressing the specific needs of overseas firms in areas such as foreign exchange remittance, profit repatriation, import of components, labor costs, and overseas training.

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[40] See also Steven R. Hendryx, "Implementation of a Technology Transfer Joint Venture in the People's Republic of China: A Management Perspective," *The Columbia Journal of World Business*, Volume XXI, Number 1, Spring 1986, pp. 57-66, which deals with Otis Elevator Company of the U.S. and the Tianjin-Otis joint venture.

[41] Richard G. O'Lone, "MD-82 Aircraft Production in China Presents Management Challenges," *Aviation Week and Space Technology*, Feb. 24, 1986, pp. 42-45.

[42] "Joint-Venture Bliss Ends in China," op. cit.

[43] Gareth C. C. Chang, President, McDonnell Douglas China, Inc., Personal communication, September 1986.

In addition, foreign firms usually complete necessary negotiations in a relatively short period of time in these other markets, and their projects are much less subject to government control than in China.

For all of these reasons, China is less competitive in attracting investment. In some respects, many of the firms that began their Asian operations in places such as Taiwan and South Korea seem to anticipate a similar evolution in China. China has gone much further than other socialist countries in allowing equity-based investments, even to the point of accepting wholly foreign-owned projects. However, the general consensus remains that the process of change in China will be slow and that the emphasis on strong control will remain a part of the Chinese investment setting. Doing business with the socialist managers of China's nonmarket economy will never be as easy as doing business in the market economies of Singapore, Taiwan, or Hong Kong.

CASE STUDIES

This section reviews the technology transfer endeavors in China by various U.S. firms in the fields of transportation, satellite telecommunications, and computers and electronics. The U.S. companies involved in China have ranged from very large diversified companies, such as GE and IBM, to small firms selling in specific market niches. The technologies involved range from manufacturing simple circuit boards to establishing satellite telecommunications networks. The case studies that follow cover sales (with a technology transfer component), joint ventures, and coproduction, and give an indication of how things work in practice.

Transportation

Locomotive Sales by General Electric

China places particular importance on its railroads. Priority projects presently under way are largely related to coal transport from Shanxi Province to other provinces and ports, and to electrification and double-tracking of existing major trunk lines.[44] The new-line construction between Datong and Qinhuangdao is the largest in scale, with investment totalling over 4 billion yuan. The Seventh Five-Year Plan proposes the construction of 3,600 km of new lines, the double-tracking of 3,300 km, and the electrification of 4,000 km of existing lines.[45]

China plans to replace steam engines with electric and diesel versions. By the year 2000, China hopes to have 20,000 km of electrified railway. China's railroad system is not under the Transportation Ministry but under its own Railroad Ministry, which sets development priorities. China's present rail system and ambitious planned improvements are shown in figure 4.

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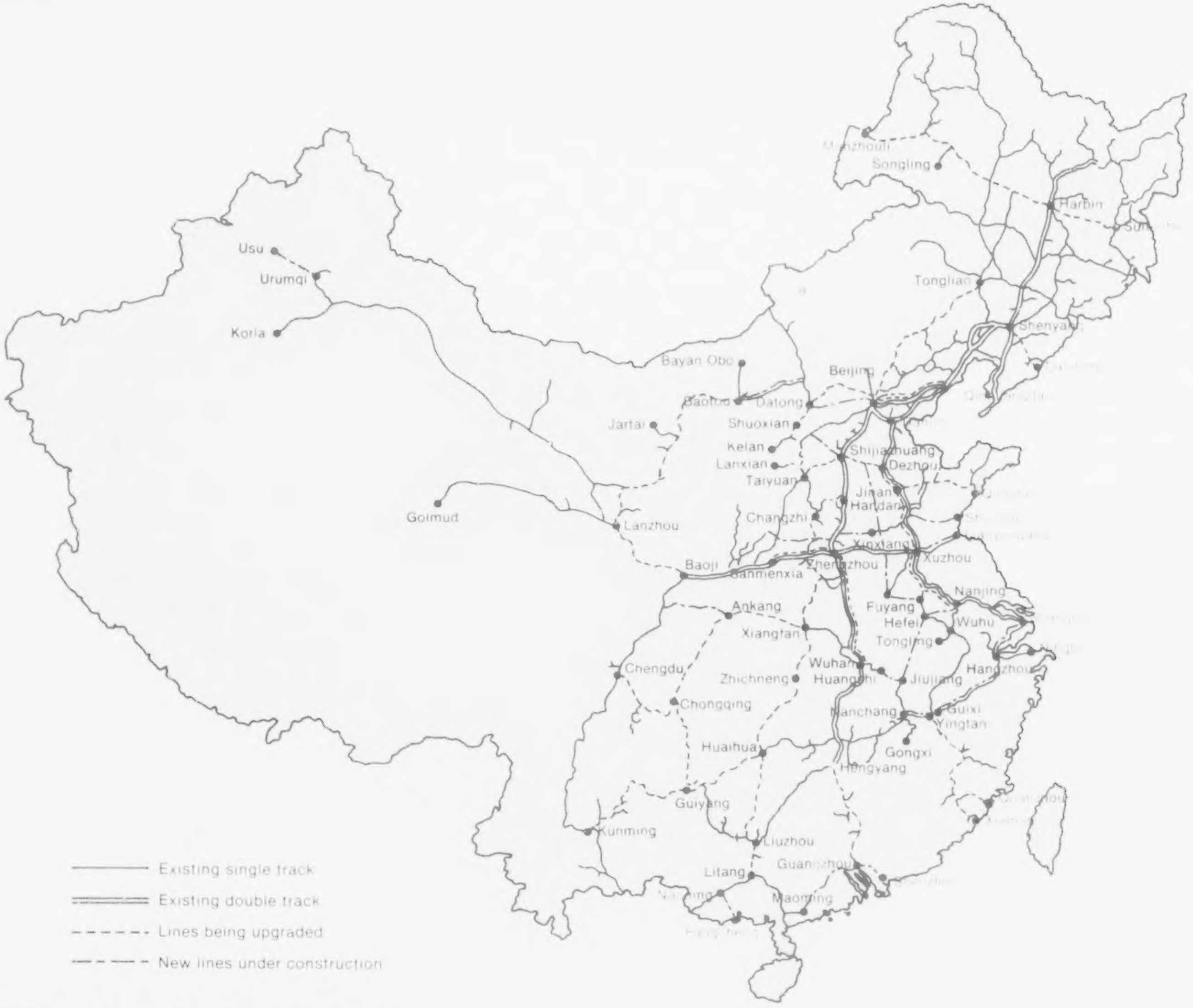
[44] See for example "Electrification Planned for 3000 km of Railways" *XINHUA*, Apr. 12, 1986 or "Modernization of Guangzhou-Shenzhen Railroad," by Dai Quan and Li Zhenxing in *TIEDAO ZHISHI* [Railway Knowledge], No. 4, July 28, 1985.

[45] Seiichi Nakajima, "China's Priority Projects and the 7th Five Year Plan," *China Newsletter*, No. 63, JETRO, 1986, pp. 13-16.

Figure 4.—China's Railroad System and Planned Improvements


Manzhouli
Songling
Harbin
Tongliao
Shenyang
Usu
Urumqi
Korla
Bayan Obo
Beijing
Baotou
Datong
Shuoxian
Jartai
Kelan
Lanxian
Shijiazhuang
Dezhou
Taiyuan
Jinan
Handan
Goimud
Changzhi
Lanzhou
Xinxiang
Xuzhou
Baoji
Sanmenxia
Zhengzhou
Nanjing
Fuyang
Hefei
Wuhu
Ankang
Xiangtan
Tongling
Chengdu
Wuhan
Huangshi
Hangzhou
Zhichneng
Jiujiang
Chongqing
Nanchang
Guixi
Yingtan
Huaihua
Gongxi
Hengyang
Guiyang
Kunming
Liuzhou
Guangzhou
Litang
Maoming
Existing single track
Existing double track
Lines being upgraded
New lines under construction

SOURCE: *China Business Review*, September-October 1984

China began to import locomotives in 1958, most of them from Hungary. In the years that followed, China bought locomotives from the United States, the Federal Republic of Germany, France, the Soviet Union, Romania, and the German Democratic Republic. At present, China's Dalian Locomotive and Car Works produces 130 locomotives a year, and its Zhuzhou Electric Locomotive Works produces 80 electric locomotives a year. China has two other factories that build passenger trains. However, China's need for locomotives and related equipment is far from being met by domestic production and imports combined.[46] The United States has become the largest locomotive supplier to China. In March 1985, 220 GE diesel locomotives of 4,000 horsepower each were delivered, with 200 more locomotives on order.

The first contact between GE and the Chinese occurred in 1976, when GE conducted a seminar on diesel locomotive technology in China. Another seminar was given in 1978, after which a Chinese delegation visited U.S. diesel locomotive plants as part of a worldwide tour. As a result of these seminars and tour, the Chinese invited GE to discuss possible diesel locomotive sales.[47] Negotiations began in 1979 but were not completed until 1983, when locomotives were given a high priority by the Chinese in a ranking of major projects.

Right from the start, technology transfer was a prerequisite of Chinese negotiations for any purchase of locomotives. GE's purchase of locomotive components from China was also very important in negotiating the two contracts. This type of countertrade will probably become more and more important as Chinese foreign exchange reserves decrease.

Throughout the entire negotiation process, GE worked with the same Chinese officials, who represented the Railways Locomotive Bureau, the Railways General Industry Bureau, and the China National Machinery Import/Export Corporation. Over the years, a good relationship developed, so the second contract took much less time to negotiate.

The first contract stipulates that the technology transfer portion is for a period of 4 years and includes manufacturing and materials technology for certain components of the locomotive, but not design methods. So far the Chinese have not asked for a particular technology that was not appropriate to their needs.

The second China contract stipulates that GE will train Chinese personnel to overhaul locomotives and will provide a factory management training course. Training will be done both in China and in the United States using computers such as IBM personal computers (PCs). Language problems had some impact on the technology transfer process, but the problems were surmountable.

GE apparently had no need for U.S. Government assistance. They felt that they had prepared themselves well and knew whom to contact and how to keep negotiations running smoothly. However, GE feels that several factors affected by U.S. Government policy are important:

- The high value of the dollar at the time of the negotiations hurt U.S. companies' competitiveness in China, just as it did elsewhere. The exchange rate when negotiations began on the first GE contract was 1.80 yuan to the dollar. Today, it is over 3.69.
- The importance of Export-Import Bank financing should be recognized—it is almost the only leverage the U.S. Government has to support U.S. industry. GE believes that other governments provide financial subsidies to companies doing business in China. Financing was not a factor in these GE negotiations since China paid cash, but the availability of official (but unsubsidized) financing could be crucial in the future.

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[46] For a detailed look at several rail technologies needed by China see "A Report Covering the Railroads of the People's Republic of China, Operations, Rolling Stock, Standards and Planning, Effects of Interface and Technology Transfer Between North American Railways, Railway Supply Companies and the Association of American Railroads," prepared by David G. Blaine and William J. Harris, Jr., May 1986 (app. 4, vol. II of this report).

[47] The Chinese use of delegations (both to and from China), technical seminars, conferences, and exhibits are a common informal technology transfer mechanism. Foreign technology seminars in China have been used a great deal and with apparent effectiveness.

- U.S. Government promotion should focus on products in general rather than on company-specific products. It might be useful for the Department of Commerce or other appropriate Government agencies to analyze the Chinese Five-Year Plan and match Chinese needs with U.S. strengths.

The protocol between the Ministry of Railways and the U.S. Government was not particularly useful, but it did not hurt, either. Thus far, export controls have not affected the export of locomotives and locomotive technology to China.

GE was particularly interested in the Chinese locomotive market because it had spent $500 million modernizing its locomotive plant in Erie, Pennsylvania. At present, the market for locomotives in the United States is poor. The two China contracts, even if they produce little or no profit, allow GE to refine technological and design advances while the plant operates. When demand returns, GE will be well placed competitively.[48]

Beijing Jeep Joint Venture with AMC

China's automobile manufacturing began in 1956 with the production of Liberation trucks at the Changchun No. 1 auto plant. These 4-ton trucks were manufactured using Soviet equipment and technology. The production of Liberation trucks kindled an interest in several types of motor vehicles required to satisfy China's burgeoning needs. In Shanghai, Nanjing, and Jinan, a variety of models were produced including the Yellow River and the Leap Forward trucks, the Red Flag limousine, and Shanghai sedans. Today, more than 50 kinds of vehicles in six categories—vans, cross-country vehicles, dump trucks, tractors, buses, and sedans—are in production, with more than 300 types refitted for special purposes.[49] Production by vehicle category is given in table 5, and total automobile production levels are given in figure 5. Production levels are still too small to achieve economies of scale, even for components. In addition, Chinese motor vehicle technology is over 20 years old, which affects vehicle production, fuel efficiency, maintenance needs, and pollution control.

Table 5.—Chinese Production by Vehicle Category

(Unit: 1,000 units)

	1981		1983	
Trucks	108.3	(61.6%)	148.0	(61.7%)
Jeeps	15.5	(8.8%)	18.0	(7.5%)
Passenger cars	3.4	(2.0%)	5.6	(2.3%)
Buses	1.7	(1.0%)	4.4	(1.8%)
Others	46.8	(26.6%)	64.0	(26.7%)
TOTAL	175.7	(100.0%)	240.0	(100.0%)

NOTE: Trailers are included under "Others." If they were included with "Trucks," the percentage for trucks would reach 85 percent.

SOURCE: Makita Iwagaki, "The State of China's Automobile Industry," China Newsletter, No. 63, JETRO, 1986.

China seeks joint ventures, improved technology, specialization, and mass production, giving special emphasis to heavy-duty trucks and sedans. The China National Automotive Industrial Corporation, founded in May 1982, has actively sought links with foreign companies. It has hosted foreign delegations from auto companies, has sent technicians abroad for research and technical exchange, and has been involved in joint production agreements. In the last few years, the company has introduced advanced technology from the United States, Japan, Italy, France, Britain, and West Germany. In addition to BJC, the Shanghai-Santana is a sedan produced jointly by Shanghai and the German Volkswagen Corp. The Tianjin-Dafa van is produced jointly by Japan and China.

The rising Chinese demand for automobiles had previously been met largely by imports. However, the large-scale importation of vehicles ended in 1986 with a clamp-down on foreign exchange expenditures. It should be noted that direct sales of cars and trucks do little for technology transfer—the backward state of China's own industry necessitated imports, and the Chinese are making efforts to remedy the situation as described below.

AMC and the Beijing Automotive Works formally inaugurated their joint venture (BJC) to produce four-wheel-drive Jeep Cherokees in

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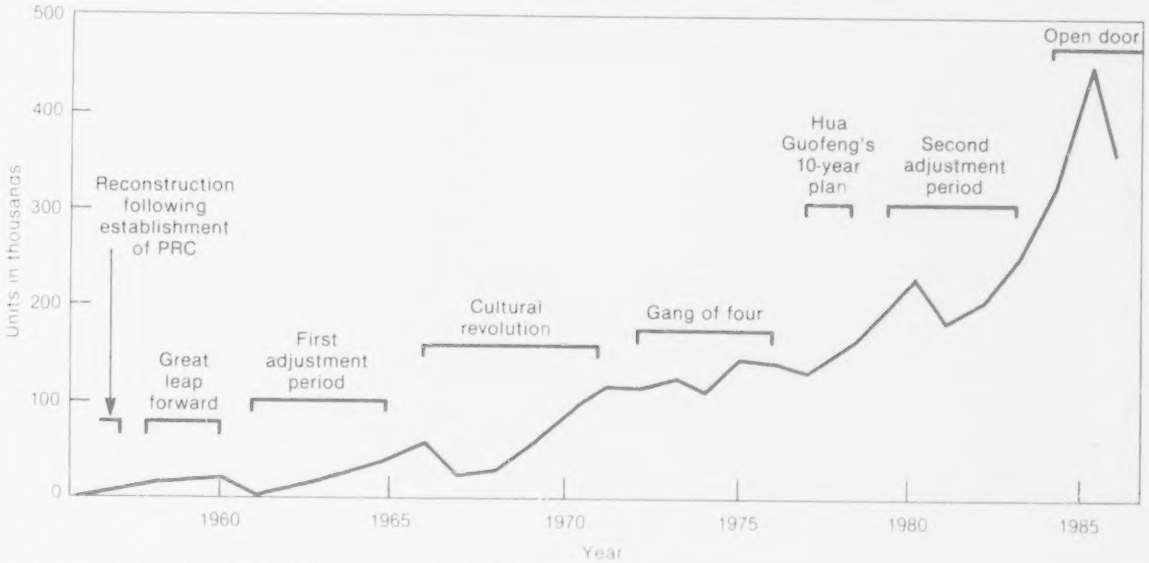
[48] Peter Petre, "What Welch has Wrought at GE," *Fortune*, July 7, 1986, p. 45. See also Barnaby J. Feder, "GE's Costly Locomotive Gamble," *The New York Times*, Jan. 25, 1987.

[49] Makoto Iwagaki, "The State of China's Automobile Industry," *China Newsletter*, No. 63, NETRO, 1986, pp. 9-11, 16.

Figure 5.—China's Vehicle Production History



SOURCE: *Zhongguo Tongji Nianjian* (China Statistics Yearbook) from Makota Iwagaki, "The State of China's Automotive Industry," *China Newsletter*, No. 63, JETRO, 1986.

Beijing in October 1985. AMC owns 31.3 percent of the joint venture. So far, AMC has invested nearly $16 million in capitalization, production equipment, and living expenses for the expatriate staff.[50]

The first phase is the assembly of CKD Cherokee kits shipped from the United States. This will be done at a plant that for many years has manufactured a modified Soviet-designed jeep, vehicles that are fuel inefficient and, on average, have major drive train failures within their first 12,500 miles. The Chinese are hoping that their experience in assembling Cherokees will teach them how to improve this vehicle. In particular, the improved quality control of assembly and locally sourced parts will be important.[51]

AMC has shipped almost 2,000 Cherokee kits to China, 1,782 of which had been assembled by January of 1987. The largest single buyer of Cherokees is the State Materials Bureau, which purchased 200 of the first 500 vehicles sold, mostly for distribution to other state agencies and enterprises. Other buyers include the Mongolian police department and several foreign companies stationed in China.

Some problems with the joint venture developed early.[52] The original 1983 contract called for a $10,000 portion of each $19,000-Cherokee sold in China to be paid in dollars. When the Chinese Government clamped down on foreign exchange outlays, however, BJC was left with a $2 million foreign exchange debt from the State Materials Bureau and an insistence by Beijing that remaining vehicles be

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[50] "Cash Shortage Forces AMC to Review Cherokee Production in China," *China Business and Trade*, Apr. 23, 1986, p. 3.

[51] Visit by OTA staff to Beijing Jeep Corp., Jan. 28, 1986.

[52] Some observers believe that the original contract was poorly conceived and that AMC should take much of the blame for this. Subsequent problems they believe stem as much from inadequate financial planning and unrealistic capitalization as they do from any problem inherent in doing business in China. (Steven R. Hendryx, "The China Trade: Making the Deal Work," *Harvard Business Review*, July-August 1986, pp. 75-84.) The venture's experience to date suggests that timetables calling for 80 percent local content by 1988 and 10,000 exported vehicles in 1990 were unrealistic. Also, many foreign observers point out that AMC's initial cash contribution of $8 million was very small in relation to its goal of building an export-quality jeep in China. ("Problems at Two Joint Ventures—Fundamental Problems Plague AMC Joint Venture/If Things Go On Like This, There'll Never be a Chinese Detroit," *The China Business Review*, July-August 1986, pp. 34-35. The second joint venture referred to in this article is that of Shanghai-Volkswagen Automotive Company Ltd. producing Santana sedans.)

Photo credit: Eric O. Basques

The Beijing Automotive Works produces two types of jeeps in parallel assembly lines. The BJ-212 pictured on the right is a Soviet-designed jeep that has been produced since the 1950s. The Cherokee Jeep on the left is a product of the Beijing Jeep Corp. Ltd., a joint venture formed with American Motors Corp.

bought only with Chinese currency. Production of Cherokees dropped to seven vehicles a day, about one-half the output rate hoped for. The original 1986 production target of 4,000 was thus lowered to less than 2,000.

This joint venture came very close to failing, primarily because of these foreign exchange problems, with AMC threatening to walk away from the deal. However, the joint venture is too large and symbolically important for either side to let it fail. The importance was underscored by the extensive discussions of AMC with the China National Automotive Industrial Corp.,[53] the State Economic Commission, and the State Planning Commission on the joint venture's problems. Some feel that the much-publicized difficulties of this joint venture in the international press helped AMC obtain this much-needed assistance from the highest levels. Recent reports indicate that many of the problems have been solved.[54]

McDonnell Douglas MD-82 Commercial Aircraft Coproduction

China is one of the few countries in Asia to have developed its own combat aircraft.[55] The Chinese developed the Shenyang J-8 *Finback* fighter, which made use of technology acquired from the manufacture under license of Soviet aircraft such as the MiG-21. The Chinese F-8-

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[53] The government has recently replaced the China National Automotive Industrial Corp. (CNAIC) with a federation which will provide China's more than 2,000 automobile and motorcycle manufacturing enterprises with consulting services and guidance in order to help coordinate the automobile industry. The reason for the demise of CNAIC, which started in 1982 with high hopes for automobile production coordination, was that its excessive power stifled the initiative of individual enterprises. (*China Business and Trade*, vol. VIII, Issue 17, Mar. 23, 1987, p. 4.)

[54] The Beijing Jeep Corp. Ltd. recently held an exhibition on its three-year anniversary. The joint venture has so far produced 1,782 Cherokee Jeeps with domestic content reportedly accounting for one-sixth of the jeeps total cost. Dividends were shared by AMC and the Chinese for the first time in 1986. The Chinese and American managers agreed to reinvest $101.25 million in the expansion of production during the country's Seventh Five-Year period (1986-1990). ("Joint Venture on Jeeps Marks Anniversary," *XINHUA*, Jan. 15, 1987.)

[55] The Chinese have announced plans to display four of their aircraft at the 1987 Paris Air Show which starts June 12, 1987 in LeBourget, France. This is China's first aircraft presentation at this biennial salon. The four aircraft are the Nanchang A-5 and Xian FT-7 fighters, the Harbin Y-12 twin-turboprop utility transport, and the Northwestern Polytechnical University D4 RD remotely piloted vehicle. ("Chinese Plan to Display Aircraft at Paris Air Show," *Aviation Week and Space Technology*, Jan. 19, 1987, p. 21.)

2 is a Mach 2.2, delta-wing, air-superiority fighter derived from the J-8 fighter.[56]

China also laboriously (and expensively) built two prototype airliners in the Boeing 707 category, designated as the Y-10 or, as some termed it the "708."[57] This airliner was extensively reverse engineered from the Boeing 707s bought by the Chinese. The engines of the Y-10 were of U.S. manufacture. The first Y-10 was used for structural tests, and the second was for actual flying tests for airworthiness. The second plane began flight testing in September 1980 and flew successfully for a total of about 300 hours.[58] One major problem with the plane was the integrity of its fuel tanks—the Chinese were accustomed to the Soviet style of aircraft building, which uses bladders or tanks for the fuel, not the U.S. style, which uses "wet wings" (the aircraft wing itself is a fuel tank). Such problems and doubts about obtaining international acceptance led to a decision not to manufacture the Y-10, but to join instead with McDonnell Douglas.

In April 1985, McDonnell Douglas and Shanghai Aviation Industrial Corp. (SAIC) signed an agreement providing for the coproduction of 25 MD-82 twinjet transports, with an option for 15 more. The agreement took 10 years to finalize. The Chinese had earlier produced landing-gear door subassemblies for McDonnell Douglas commercial airliners. McDonnell Douglas was satisfied with the quality of the work on the over 200 doors assembled and decided to go forward with a proposal to coproduce 25 MD-82 commercial airliners in Shanghai with the Chinese.[59] The Civil Aviation Administration of China (CAAC), the umbrella Chinese organization that oversees all aspects of aviation, has agreed to acquire the 25 MD-82s. The five other MD-82s have already been put into service by regional carriers in Shanghai and Shenyang.

Thirty-eight engineers and specialists from the United States are staying at the McDonnell Douglas coproduction facility in Shanghai, run by the SAIC. They stay from 2 months to up to 2 years. The contract also specifies that approximately 220 Chinese will travel to the United States for training, most of them in planning, engineering, and assembly. Of these 220, approximately 90 percent will be engineers and 10 percent technicians. In 1987 they intend to coproduce 2 planes. The post 1987 timetable is not definite, but they hope to assemble four planes in 1988, seven in 1989, eight in 1990, and four in 1991.[60]

The McDonnell Douglas coproduction agreement is complex, with 500 pages (in both English and Chinese) five parts covering:

1. licensing details
2. delivery of aircraft to CAAC and aftersales service,
3. offtrade (countertrade) agreements,
4. new joint development of aircraft, and
5. discussion of a new joint management system.

The total deal covers a period of about 10 years.

A major step for the Chinese is now completed with the signing of the "Memorandum of Agreement for Technical Cooperation in the Field of Civil Aviation" between the FAA and the CAAC.[61] This agreement, along with its Annex 1, certifies FAA airworthiness to the MD-82s being assembled in Shanghai and is essentially an extension of the airworthiness certificate given to the MD-80 series of aircraft manufactured in McDonnell Douglas' Long

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[56] The U.S. Air Force and the People's Republic of China signed a $501 million contract in October 1986 to upgrade the F-8 fighter with U.S. made avionics equipment. A draft request for proposals has been issued by the Air Force and a formal RFP will go out in early March 1987 with a contract award planned for August. Delivery of the first 50 kits and five spares is scheduled for 1991. The kits will include new radars, inertial navigation equipment, head-up displays, air data computers, and a new data bus. ("Chinese F-8-2 Fighter Configured for All-Weather Day/Night Missions," *Aviation Week and Space Technology*, Jan. 19, 1987, pp. 42-43.)

[57] See, for example, E. E. Bauer, *China Takes Off: Technology Transfer and Modernization*, University of Washington Press, 1986, concerning several interesting technology transfer histories.

[58] Visit by OTA staff to the Shanghai Aviation Industrial Corp. plant, Shanghai, Feb. 4, 1986.

[59] Shanghai site visit by OTA staff, Feb. 4, 1986.

[60] Visit by OTA staff to the Shanghai Aviation Industrial Corp. plant, Shanghai, February 4, 1986.

[61] "Memorandum of Agreement for Technical Cooperation in the Field of Civil Aviation between the United States of America Department of Transportation, Federal Aviation Administration and the People's Republic of China, Civil Aviation Administration of China," signed Mar. 14, 1986 and "Annex 1 to the Memorandum of Agreement" signed Mar. 15, 1986.

Beach facilities. With this certification the MD-82s assembled in China can be flown or sold anywhere in the world. McDonnell Douglas actually monitors the Chinese work in assembling the SKD (semi-knock- down) units to make sure that the completed aircraft are in compliance with FAA requirements. FAA inspectors from Long Beach also go to China approximately every 3 months to check for compliance.[62] In May 1986, Annexes 2, 3, and 4 were drafted and sent to the Chinese. These annexes deal with controlling air traffic, maintaining airworthiness, and developing an air traffic control system plan. The Chinese have expressed an interest in these but do not want to commit foreign exchange to them at this time.

The MD-82 production line started as planned on April 1, 1986, with the first plane completed in June 1987, 1 month ahead of schedule.[63] This plane will be test-flown to see that it is airworthy and operates to FAA specifications, with delivery in July. Subsequent planes will then be essentially replicas of this first one.

China's aircraft industry is developing new types of 100-seat jet planes in cooperation with Messerschmitt-Bolkow-Blohm (MBB) of West Germany and McDonnell Douglas. This cooperative arrangement was signed in April 1985. China has sent over 200 senior specialists from its aircraft industry to West Germany and the United States to help design and produce the new aircraft.[64]

One reason for so much interest by foreign firms is that the potential market for aircraft in China is enormous. Unlike other countries in the region, China contains a home market for aircraft that, by itself, is large enough to justify at least the development of aircraft sized for regional markets. In this respect, China can be compared only with the United States and the Soviet Union.[65]

Satellite Telecommunications

Background

According to a recent Department of Commerce Industry Sector Analysis for Telecommunications in China, "China recognizes that telecommunications is one of two or three industries upon which the fate of its entire modernization rests. The principal focus is on rapid improvement of what can only be described as an appalling telephone system."[66] Only 1 person in every 200 has a phone, placing China among the lowest six countries in the world in phone density. Long waits for connections, poor line quality, and lack of service are continual problems. Much of the equipment dates back to the 1930s and 1940s. Chinese international telecommunications capacity has been developing at a rate of 30 percent a year (albeit from a small base), mostly through increasing communications by satellite. China can produce several types of equipment, including ground stations (particularly C-band) and telephone transmission lines, but these are generally not technically sophisticated.

Satellite telecommunications is a very appropriate high-technology sector for China. China's large population, spread over vast land masses with extreme variations in climate and terrain, makes this an ideal technology- better even than microwave transmission, in most cases. Fiber optics would be a contender only on high-volume trunk lines between major cities or for military uses requiring a high degree of security. The Chinese realize that telecommunications is an extremely important part of their national infrastructure, and many of their ambitious development plans are closely tied to it. They also realize that there is military and propaganda value to increased telecommunications capabilities. However, with limited resources, telecommunications development has come and will probably continue to come after agriculture, transportation, and energy development.

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[62] "Chinese MD-82 Procedures Under Review," *Aviation Week and Space Technology*, May 25, 1987, p. 29.

[63] See Bruce A. Smith, "Chinese Join Wings, Fuselage of First Coproduced MD-82," *Aviation Week and Space Technology*, Dec. 15, 1986, pp. 41-43 and "First Chinese-Assembled MD-82 Nears Completion in SAIC [Shanghai Aviation Industrial Corp.] Facilities," *Aviation Week and Space Technology*, June 1, 1987, pp. 34-35.

[64] "[Chinese] Aircraft Industry Cooperating with U.S., FRG," *Xinhua*, Nov. 21, 1985, reported in JPRS-CEA-85-112, Dec. 20, 1985.

[65] Pierre Condom, "The Far East—Today's Customer . . . ," Japan, of course, despite being a small country, also has strong reasons for developing its own aircraft.

[66] "Telecommunications in China—Industry Sector Analysis," U.S. Department of Commerce, Washington, D.C., 1985.

China has three options for achieving satellite telecommunications capability: It can lease the capacity on existing satellites, buy satellites from other countries, or develop its own capabilities. China is actually pursuing all three options. INTELSAT (International Telecommunications Satellite Organization) has provided transponder capacity to China, and this was expanded with the purchase by China in 1986 of two transponders from the satellite at 66 degrees East longitude. One of the transponders is used for educational programming, and the other for news and cultural programming.[67] China has also investigated the purchase of satellites, as discussed below. Purchase or lease of a system for complete coverage of the entire country would be prohibitively expensive, however, considering China's great needs.[68]

China has significant expertise in both scientific satellites and rockets (see table 6 for a chronology), but its communication satellites in particular are far behind the best Western technology.[69] Technology transfer is probably the best compromise. China can buy several satellites and associated technology from the United States or Europe, and it can use this to greatly speed up its own development.

Satellite Telecommunications Technology Transfer

China requested foreign proposals for substantial development of its satellite telecommunications capabilities in the late 1970s and again for 1984-85. In the earlier case, the respondents to the request for proposal (RFP) were Hughes Aircraft, GE, and RCA-Astroelectronics of the United States, MBB from West Germany, and British Aerospace Dynamics.

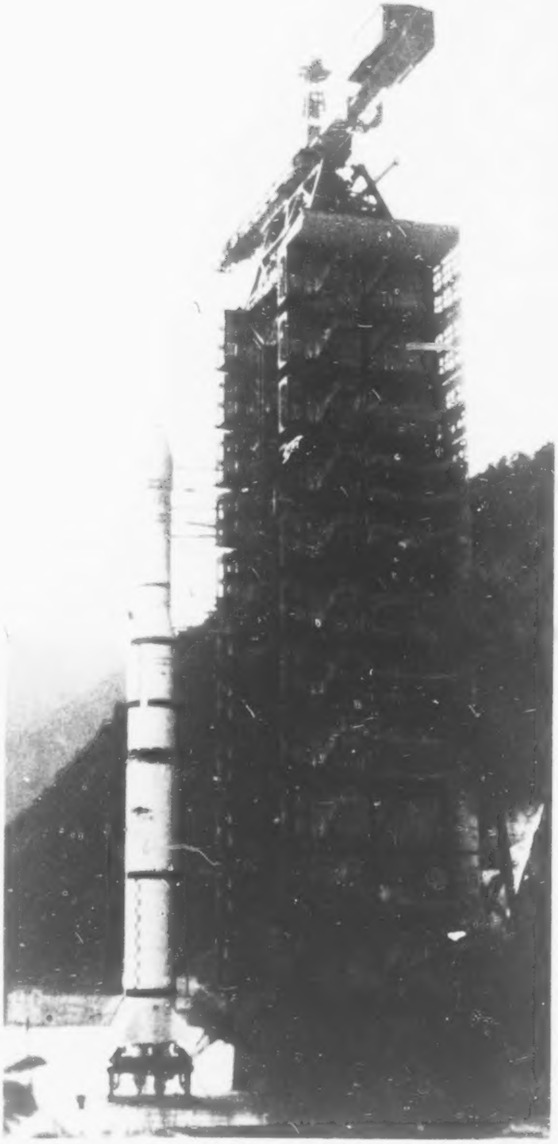

Photo credit: China Great Wall Industry Corp.

The main thrust of the Chinese drive for commercial launch business is the Long March 3, shown above at the Xichang launch site. This vehicle is essentially a Long March 2 with the addition of a new cryogenic third stage which boosts the payload into a geostationary transfer orbit. The Long March 3 has been launched three times with the latter two being successful.

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[67] Radhakrishna Rao, "China's Space Plan," *Satellite Communications*, February 1987, pp. 25-27.

[68] Leasing of one communications satellite transponder costs about $30 million per year. This does not include ground equipment. Depending on the type, central ground stations cost from 0.5 to 4.0 million dollars apiece. Buying an entire satellite communications system (which would have several transponders) could cost 120 to 150 million dollars with the satellite lasting 9 to 14 years. The U.S. civilian sector presently has 150 to 200 active transponders. INTELSAT has about 330 to 340 transponders available for use and is presently operating at about 50 percent of capacity.

[69] China's particular needs are in increasing communications satellite power and longevity and in improved satellite stabilization and control.

Table 6.—Satellite Telecommunications Development in China: A Chronology of Important Events

1956	Chinese Astronautics industry development begins.
1960	USSR technicians depart, thus ending technical assistance in production of liquid fuel rockets.
1965	Beginning of research and design of first satellite and carrier rockets.
1968	China Academy of Space Technology formed to coordinate space program.
1970	*Chinasat 1*: April 24, 173 kg. China becomes fifth country to develop launch capability and launch its own satellite. Tracking, telemetry, and command network of seven stations in place. Satellite circled the Earth every 114 minutes, broadcast "The East is Red."
1971	*Chinasat 2*: March 3, 221 kg. Experimental scientific.
1972	RCA Globcom erects first satellite earth station in Shanghai.
1974	*Long March 2*: launch failure.
1975	*Chinasat 3*: July 26, 1750 kg. Scientific satellite. *Chinasat 4*: November 26, 1750 kg. Reconnaissance satellite. Returned to Earth December 2. China is third country to master satellite return technology. *Long March 2* problem corrected and all subsequent launches with this rocket are successful. *Chinasat 5*: December 16, 1750 kg. Meteorological satellite.
1976	*Chinasat 6, 7*. China becomes member of Intelsat. Leases 60 half-way international telecommunications circuits.
1977	China Academy of Sciences organizes Space Science & Technology Center for space research.
1978	*Chinasat 8*: January 26. Conducted scientific experiments. Begin negotiations with U.S. companies for import of direct broadcast satellite. Joint tests with France and Germany on European satellite. Joint tests with U.S. (RCA) on Marisat. First Chinese aerospace delegation to the U.S.—NASA invitation.
1979	NASA and AIAA visits to China. Cryogenic fuels development revealed. China only third country to use cryogenic third-stage rocket. Deng Xiaoping visits Johnson Space Flight Center in Houston.
1980	China begins astronaut training (later abandoned). Satellite purchase postponed on grounds of "economic readjustment."
1981	*Chinasat 9, 10, 11*. China (CAST) begins discussions with NASA for science and technology exchanges.
1982	*Chinasat 12*: September 9. Scientific experiment.
1983	*Chinasat 13*: August 19. Scientific satellite. China-Italy joint tests with Italian *Sirius* satellite. U.S. Government issues more liberal guidelines for licensing of technology exports to China. *Landsat* ground station finally approved.
1984	*Chinasat 14*: January 29. First successful launch with *Long March 3* (CZ-3). Gas generator burnout prevents proper payload positioning. First liftoff from new spaceport in Sichuan Province. *Chinasat 15*: April 8. Successful launching of communications (test) satellite on CZ-3. Geosynchronous equatorial orbit. *Chinasat 16*: September 12. United States sends "presidential" aerospace trade mission to China. China and Germany sign agreement for space technology cooperation including joint development and manufacture. Canada's Spar Aerospace sells China ground station package valued at over $24 million (Canadian). In August, RFP for Direct Broadcast Satellite (DBS) issued.
1985	*Chinasat 17*: October 21. Resource survey. *China Daily* on June 13 announces that China is ready to market space products and services. At Stockholm International Aeronautical Federation Congress, China describes launch failures, provides launcher details. China opens new space launch complex to potential customers. People to People, NASA, AIAA groups of US aerospace technicians visit China. On July 15, China postpones RFP for DBS. August 1: China begins 3 months of free trial on Intelsat satellite for educational T.V.
1986	*Chinasat 18*: February 1. CZ-3 launch of "operational" commercial satellite. Geosynchronous orbit. Several Western companies make launch reservations with the Great Wall Industries Corp. which markets Chinese launch services.

SOURCE: Office of Technology Assessment, 1987.

In the later case the respondents were RCA-Astroelectronics (now GE Aerospace-Astrospace Division), Matra of France, and MBB teamed with Ford Aerospace (United States). In neither case did the Chinese sign a contract.

The amount of technology transfer offered by the foreign companies was an important bargaining point in both cases. The Chinese reportedly were quite skillful in playing off the competing companies against one another. As it turned out, the Chinese received a great deal of technological information, essentially for free, from these two aborted satellite telecommunications RFPs. Some feel that the first round immensely helped the Chinese and led to their space successes in the early 1980s.[70] Most people feel, however, that the Chinese bargained in good faith: a lack of foreign exchange and bureaucratic infighting over the type of satellite system China should have were the real problems.[71]

Eventually, China resolved the systems issue with the selection of the low-power C-band instead of the higher power Ku-band, which had been the subject of the RFP.[72] [73] The conflict had resulted largely from the different communications needs of several Chinese ministries and the military.[74] The complexity of the bureaucratic structure involved in the selection, production, and application of space communications technology is shown on the organization chart of figure 6. This complexity typifies much of the Chinese bureaucracy, and is largely responsible for the delays in decisionmaking.

Chinese Satellite Expertise

China launched its first geosynchronous satellite in 1984 and a second in February 1986, demonstrating an ability to move rapidly in areas of particular interest. However, in most aspects of satellite telecommunications technology, the Chinese are 20 years behind the United States and Western Europe.[75] These satellites have worked, but they are heavy (considering their low power) and will probably be short-lived. In addition, the Chinese have, until recently, had little use of the satellites, since the ground-based infrastructure was largely nonexistent.

The Chinese have a great deal of the theoretical, or "academic," expertise required for successful development of sophisticated satellite telecommunications equipment. But, with the exception of ground antennas, they have not had the practical experience of designing, building, and operating viable, efficient systems. Satellite attitude control and

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[70] Satellite telecommunications demonstrates the Chinese capability to advance through informal technology transfer. The Chinese developed a great deal of satellite and launch capability on their own and through study of technical literature. Although development cannot be achieved across-the-board through such methods, it is interesting that the Chinese were able to move ahead in these areas despite the overshadowing of scientific effort by the Cultural Revolution. Part of the push in this field came from military desires, of course.

[71] An unsuccessful early bid, however, does not prevent a subsequent successful bid in a related area. For example, France's Matra was not successful in its proposal to China for a telecommunications satellite system. However, the Chinese were interested in the satellite control center portion of their proposal and out of this came an agreement for supply of data processing centers at two Chinese ground stations valued at $8-10 million. ("France to Supply China with Data Processors," *Aviation Week and Space Technology*, July 21, 1986, p. 25.) Matra hoped to sign the final contract in October 1986 with deliveries beginning in 1987. The processing centers will be based on Digital Equipment Corp. VAX computers, which were specified by China. The contract was signed in December 1986 for $7.8 million ("Matra Will Supply Data Processing Equipment to China," *Aviation Week and Space Technology*, Dec. 8, 1986, p. 27. The DEC Model 8500 was originally specified, but the Chinese have now specified the improved technology Model 8700, partly because the 8500 is being phased out in 1987 by Digital Equipment Corp. A request based on the changeover to the 8700 computer has been filed with COCOM with approval expected in the next several months. ("New Computers Selected for Chinese Stations," *Aviation Week and Space Technology*, May 11, 1987, p. 33.

[72] C-band operates at a frequency of 6 Gigahertz (GHz) uplink from the sender to the satellite and 4 GHz downlink from the satellite to the earth station. Ku-band operates at 14 GHz uplink and 12 GHz downlink (1 GHz = 91 billion cycles per second). See the OTA Case Study contractor report "Satellite Telecommunications Technology Transfer to China" by China Business Development Group, Alexandria, Virginia, July 1986 (Appendix 3, Vol. II), for an extensive discussion of the relative strengths and weaknesses of the two systems.

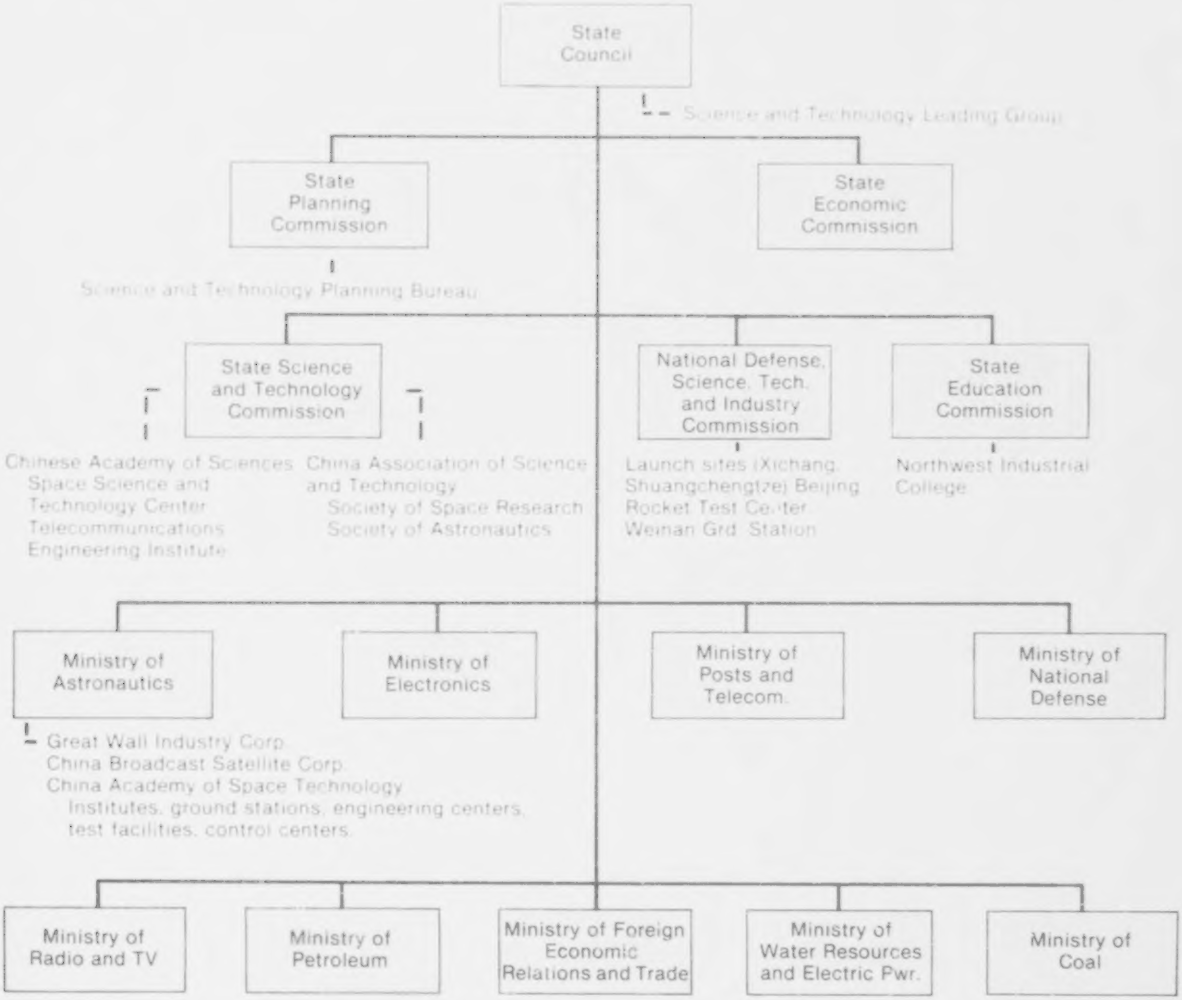
[73] It is unknown, at this point, whether they will issue a 3rd RFP or decide to proceed on their own.

[74] Primarily the Ministry of Astronautics, Ministry of Electronics, Ministry of Radio and Television, and the State Education Commission. For the interested reader, an extensive discussion of this matter is contained in the OTA Case Study contractor report "Satellite Telecommunications Technology Transfer to China," July 1986 (app. 3, vol. II of this report).

[75] Ibid.

Figure 6.—China: Satellite Telecommunications Technology Transfer

Chinese agencies responsible for selection, production, and application of space communications technology


State Council
Science and Technology Leading Group
State Planning Commission
State Economic Commission
Science and Technology Planning Bureau
State Science and Technology Commission
National Defense, Science, Tech. and Industry Commission
State Education Commission
Chinese Academy of Sciences
Space Science and Technology Center
Telecommunications Engineering Institute
China Association of Science and Technology
Society of Space Research
Society of Astronautics
Launch sites (Xichang, Shuangchengtze) Beijing Rocket Test Center, Weinan Grd. Station
Northwest Industrial College
Ministry of Astronautics
Ministry of Electronics
Ministry of Posts and Telecom.
Ministry of National Defense
Great Wall Industry Corp.
China Broadcast Satellite Corp.
China Academy of Space Technology
Institutes, ground stations, engineering centers, test facilities, control centers.
Ministry of Radio and TV
Ministry of Petroleum
Ministry of Foreign Economic Relations and Trade
Ministry of Water Resources and Electric Pwr.
Ministry of Coal

SOURCES: National Council for U.S.-China Trade; *Aviation Week & Space Technology*; U.S. Embassy, Beijing; AIAA reports; *Nature*, November 21, 1985.

stabilization are presently the two specific satellite technology areas of major concern to the Chinese. In a more general sense, lack of technology infrastructure hinders China's satellite telecommunications development. The space-based component and telecommunications equipment manufacturers that provide a large, varied technical support in the United States and Europe do not exist in China.

China is now offering, on the international market, satellite launch services to geosynchronous orbit using its Long March 3 vehicle. China will also alter its Long March 2 rocket (usually used for low-earth orbit (LEO) launches) by stretching the tanks and adding four liquid rocket boosters. The new version, designated the CZ-2-4L, will lift 1,900 kg into geosynchronous orbit with the help of a PAM-D2 (payload assist module) upper stage. It is hoped to be ready by the late 1980s.[76]

Impact on the United States

Concerns have been expressed that transferring satellite telecommunications technology to China will assist the development of a competitor and the military capability of a potentially hostile country. Neither fear seems likely to be realized. Development of Chinese satellite telecommunications will not pose a threat to sales of U.S. firms for at least 10-15 years, since Chinese technology will not be good enough at any price until then. Any satellite telecommunications will improve the capabilities of the Chinese military to some extent, but the technology transfer aspects are not directly very worrisome. Most export control concerns related to this technology stem from miniaturization technology and increased digital processing and computer capabilities of the Chinese, which are likely to come from other sources as well.

Launch services, however, if subsidized by the Chinese and proven reliable, could well cut into *Shuttle* or *Ariane* launch sales.[77] Several customers have recently announced that they are planning to launch their satellites on China's Long March rockets, largely because of the unavailability of other slots and the relatively low prices for launches by China.[78] Other potential contenders for international launch services include the Soviet Union, which has already offered its Proton rocket to launch *Inmarsat* satellites, and Japan, which may be in the commercial launch business in the early 1990s.[79]

The Chinese space program could eventually become a significant factor in satellite launch services. The U.S. Department of Transportation estimates that commercial customers will want to launch about 20-25 commercial payloads per year in the late 1980s and that U.S. companies could capture 50 percent or more of that market.[80] It is estimated, however, that the Chinese could have the capability to launch 6-12 geosynchronous satellites a year by the early 1990s, of which only two or three launches would be for their own domestic needs. Officials of the China Great Wall Industry Corp. (CGWIC), the marketing arm of China's Ministry of Astronautics, have approached 39 companies in 19 nations seeking launch service customers.[61] CGWIC also exhibited at the Paris Air Show, June 12-21, 1987.

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[76] "International Notes," *Space Business News*, July 14, 1986, p. 1. See also "PRC: Modified 'Long March' Launcher," *FBIS: Science and Technology Perspectives*, vol. 2, No. 6, Apr. 30, 1987, p. 7-8 and Craig Covault, "New Chinese Heavy Rocket Spurs Effort To Win Commercial Launch Contracts," *Aviation Week and Space Technology*, May 4, 1987, p. 22-23.

[77] See for example, "Chinese Launch Services Executives Guarantee They Can Beat Any Price," *Satellite News*, vol. 10, No. 17, Apr. 27, 1987, p. 1. Launch insurance, an important consideration nowadays, is also offered by the Chinese. See "PRC Firm [People's Insurance Company of China] to Insure Launch of U.S. Satellite," *XINHUA*, Feb. 14, 1987 and "Chinese Make Inroads on Commercial Launch Market," *Aviation Week and Space Technology*, Mar. 9, 1987, p. 134.

[78] China has won launch reservations for satellites of Pan Am Pacific Satellite Corp. and Dominion Video Satellite ("China Wins Launch Reservations for Three More U.S. Satellites," *Aviation Week and Space Technology*, Nov. 24, 1986, p. 20.) Western Union and Swedish Space Corp. are other customers of the Long March vehicle. See Liu Jianjun, "Launching Satellites for Foreign Firms," *Beijing Review*, Jan. 26, 1987, p. 30. In April 1987, China signed its first long-term agreement with a U.S. company to market commercial booster launch services. The trade service company selected by Great Wall Industry Corp. is Becker and Associates of McLean, Virginia. See Gus Bochanis, "Chinese Launch Services to Open Local Office," *Washington Technology*, May 14, 1987, p. 6.

[79] "Some Rockets Still Work," *The Economist*, Aug. 16, 1986, p. 57. See also: Natasha Wei, "Launch Wars—With the World Space Industry in Disarray, China Hopes for a Shot at the Big Time," *The China Business Review*, September-October 1986, pp. 12-15.

[80] Phillip M. Boffey, "Science to Carry on in Space, NASA Says," *New York Times*, Aug. 19, 1986.

China has been extending itself worldwide in its space efforts. China, Japan, and the United States recently held a joint meeting on space studies in Beijing, during June 1987, called the Pacific Basin International Symposium on Advances in Space Science and its Applications. This was the first time that China has invited a large group of foreign experts on space development from several countries. The forum was backed by the Chinese State Science and Technology Commission and was jointly sponsored by private organizations of the three countries, namely, the Japanese Rocket Society, the American Astronautical Society, and the Chinese Society of Astronautics. Agenda items included: 1. satellite telecommunications and development of remote sensing technology in the Pacific area, 2. space station research in the Pacific area, and 3. development of the next generation of rockets for launching satellites.[62]

Future prospects for China in space could include cooperating with the United States, Europe, or Japan in several types of space technology.[63] China and France's Matra are presently evaluating the feasibility of offering commercial microgravity flight opportunities using recoverable reentry capsules launched by Long March 2 and 3 vehicles.[64] Chinese space officials have also talked in general terms of building an orbiting space station in the late 1990s and of a shuttle sometime later, but budget imperatives have held back development outlays.[65] Nonetheless, the Chinese have also announced that they have begun choosing a team of astronauts for future Chinese space flights, although they did not give a date for these flights. The Chinese said that their scientists had developed life support systems and the biggest centrifuge in Europe or Asia to prepare astronauts for the stresses of space flight.[66] Several observers believe, however, despite the impressive accomplishments of the Chinese space program, that launching manned Chinese rockets is presently well beyond their ken.

Computers and Electronics

China's electronics industry has six major product areas: television, radio, and recording equipment; computers; radar and communication equipment; electronic components; professional and industrial electronics instrumentation and equipment; and military electronics.[67] The industry is characterized by multiple ministerial-level organizations with an interest in the research, production, and application aspects of electronics technology, components, or equipment. Also of critical importance is a series of similar research and production units under the control of provincial and municipal authorities. At times, the mere presence of these numerous organizations has made for intense rivalry and competition because each of the respective ministries and localities has desired to have its own infrastructure for meeting its electronics needs.

There are over 2,600 factories in the country's electronics industry, along with over 130 research institutes and 6 dedicated universities focused on electronics technology. The Ministry of Electronics Industry (MEI) is the most important body. The extent of direct

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[61] Craig Covault, "New Chinese Heavy Rocket Spurs Effort to Win Commercial Launch Contracts," *Aviation Week and Space Technology*, May 4, 1987, pp. 22-23.

[62] "Sources Say PRC to Host Space Studies Forum," *KYODO*, Tokyo, Japan from FBIS-Japan, Aug. 5, 1986.

[63] "International Notes—The Chinese and British Agree to an Exchange of Satellite Technicians," *Space Business News*, Dec. 15, 1986, p. 1. "International Notes—China and Japan Plan to Discuss Cooperating in Space Technology in Coming Months," *Space Business News*, Aug. 11, 1986, p. 1. Some feel, however, that Japan will be very careful in tying in with the Chinese in these technology areas. This is because Japanese space technology is now coming into its own after being hobbled for several years by a technical agreement with the United States on launcher development.

[64] "Chinese Will Launch French Payloand," *Aviation Week and Space Technology*, May 4, 1987, p. 23.

[65] John F. Burns, "China's Proud Space Program—It's Modest, But Reliable," *The New York Times*, May 19, 1986, p. D10. Also see "Chinese Make Inroads on Commercial Launch Market," *Aviation Week and Space Technology*, Mar. 9, 1987, p. 134.

[66] "China Says it Plans Manned Space Flight 'Before Long'," *New York Times*, Sept. 2, 1986, reporting on an article appearing in *The People's Daily*, Aug. 31, 1986.

[67] See Denis Fred Simon and Detlef Rehn: "*Technological Innovation in China's Electronics Industry: The Case of Shanghai*," study funded by the Volkswagen Foundation, FRG (to be published by Ballinger Publishers, Cambridge, MA).

MEI control over these facilities varies as a result of the recent divestment decision in 1985 and the degree to which local authorities are involved in overseeing the operation of specific units.[88] As presently structured, the MEI is divided into four main departments: broadcasting (television and communication), radar and navigation, electronic devices and components, and computers. The computer department is the former State Administration of Computer Industry, which was incorporated into the MEI structure during the May 1982 bureaucratic reform.

A major organizational reform occurred in the computer industry in late 1986 with the establishment of the "Great Wall Computer Group Conglomerate."[89] This reform decreased the previously dominant role that MEI had played in computer R&D and production. The formation of this conglomerate, which is known in Chinese as a "jituan," is part of the general decentralization of authority in MEI as well as the effort to create better horizontal linkages among units associated with different facets of production. The GWCGC is composed of 58 existing computer production units, 4 R&D institutes and 5 universities—all drawn from MEI, the CAS, and the Beijing municipal government. The group will undertake all phases of research, manufacturing, sales and service, and training. It will operate as an integrated entity in an effort to foster coordination and minimize administrative interference from the local or central government. The core of the group will be the China Computer Development Corporation, which will be composed of 6 smaller computer companies. A similar type of organizational effort has taken place in Shanghai with the formation of the Yangtze River Computer Group Conglomerate.

Heretofore, each department under MEI controlled a series of manufacturing and research facilities. For example, under the department responsible for computers, there was a fully articulated research and development and industrial structure containing 130 enterprises and 26 research units.[90] A select number of key enterprises are still under the direct control of MEI, including those that are mainly military oriented, though most of their project money comes from the National Defense Science, Technology, and Industry Commission or other military-related organizations. In other cases, the principle of "dual leadership" is followed; i.e., enterprises are jointly administered by central and local authorities. (This does not include those enterprises that are collectively owned and controlled.) According to one Chinese official, there can be as many as 10 different organizational forms involving different mixtures of local and central control. Similar types of organizational arrangements exist under the other ministries mentioned above, such as the Ministry of Space Industry (MSI), which has a number of branch factories and research institutes located in cities such as Shanghai. Understanding these organizational principles goes a long way toward clarifying why decisionmaking in China can be so complex and why it is so difficult to carry out successful innovation.

Of the major changes in policy and organization that have been introduced to overcome these difficulties since the early 1980s, the most prominent has been the creation of the "State Council Leading Group for the Revitalization of the Electronics Industry." This group, headed by Vice-Premier Li Peng, is designed to ameliorate the coordination problems that have dominated China's efforts to develop its electronics industry. It established the framework[91] for the development of China's electronics industry during the Seventh Five-Year Plan (1986-90) and beyond, and included the following goals:

- The overall goal of the industry is expanded application of electronics technology in or-

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[88] For details of this divestment effort see *China Daily*, Aug. 2, 1985.

[89] "New Computer Giant Eyes Home Market," *Beijing Review*, Jan. 19, 1987, pp. 5-6.

[90] See Denis Fred Simon "China's Evolving Computer Industry: The Role of Foreign Technology Transfers," June 1986 (app. 2, vol. II).

[91] See "The Strategy for the Development of China's Electronics and Information Industries" and Li Peng: "The Electronics and Information Industries Have to Serve the Construction of the Four Modernizatons," *Jingji Ribao* (Economic Daily), Jan. 14, 1985, and Xinhua, Jan. 11, 1985, *FBIS—China*, Jan. 15, 1985, pp. K25-27.

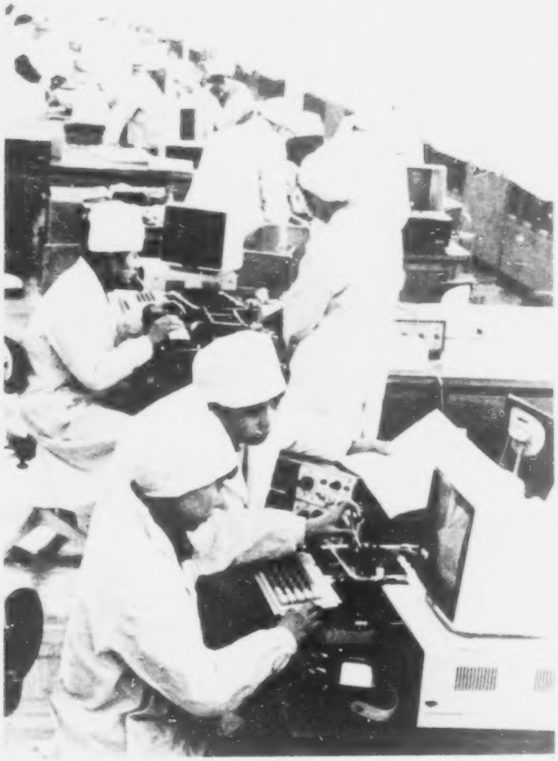

Photo credit: Xinhua News Agency

Beijing No. 3 Computer Factory, which started manufacturing microcomputers in 1981. Photo shows technicians assembling and debugging microcomputers.

der to better serve the development of the national economy and society. The popularization of microcomputers, for example, is to be stressed along with software, especially Chinese character programs;

- The acquisition and assimilation of foreign technology are to be stressed as a means of closing the prevailing gap between China and the rest of the world. Joint ventures and other forms of cooperation are to be encouraged. The aim of these measures is to complement indigenous R&D and manufacturing programs in order to "speed up the development of China's electronics industry in order to attain advanced world levels sooner and thereby increase our capacity for self-reliance;"
- Greater attention should be paid to creating a fully articulated and integrated electronics industry, capable of supplying needed components and manufacturing equipment as well as final products. Within this context, the main goal is "to achieve economical, large-scale mass production with good quality and low cost." Special attention will be given to large-scale integrated circuits; the short-term goal will be "to master selected, suitable, and advanced LSI circuits;"
- Efforts should be made to establish an effective balance between centralization and decentralization with respect to the management of the electronics industry. Electronics products that require large investment, long production time, and high technology (e.g. LSI) must be produced under unified state planning and unified arrangements in order to avoid blind development and waste of time, manpower, and materials.

The Chinese have recently had some major achievements in their computer industry, as shown in table 7. However, present problems in the Chinese computer and electronics industry include lack of experience in the field, technology not up to international standards, and too little use of Chinese products. To meet their plans for national economic development, the Chinese have pushed hard in the last few years to build up their electronics industry. However, they are not satisfied with their efforts, since they have imported much technology at considerable cost and their products, especially computers, are still not up to international standards.[92] For example, mini and mainframe computer sales to China have been substantial as shown in table 8. With appropriate foreign technology transfer, approximately 70 percent of the products of China's electronics industry could, by the year 2000, achieve the sophistication of today's products in the industrialized countries.

United States involvement in the Chinese computer and electronics market has been sig-

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[92] "Electronics Poised for Big Advance," *China Daily*, Feb. 4, 1986.

Table 7.—Major Achievements in China's Computer Industry, 1977-85

1977	Development of China's first microcomputer (DJS-050)
1979	Development of HDS-9 (5 MIPS) by CAS Institute of Computer Technology Development of DJS-052 microprocessor (eight bit, one chip)
1983	Development of China's first supercomputer ("Yinhe" ["Galaxy"], 100 MIPS) by the S&T University for National Defense in Changsha Development of the 0520 microcomputer (IBM PC compatible) by the MEI Institute No. 6 and production by Beijing Wire Communications Factory Development of the "757" 10 MIPS parallel computer by CAS Institute of Computer Technology Development of a 16-bit desk top computer (77-II) by the Lishan Microcomputer Corporation
1984	Development of the 16-bit TQ-0671 microcomputer system by the Tianjin Computer Institute (CPI: MC 68,000)
1985	Development of NCI-AP 2701 floating point array processor by MEI North China Institute of Computer Technology Development of NCI-2780 super-minicomputer (32-bit) by North China Institute of Computer Technology (Clone of DEC VAX 11/780) Development of 8030 computer by East China Institute of Computer Technology (compatible with IBM 370/138) Development of YH-X1 super-minicomputer by the S&T University for National Defense in Changsha

SOURCE: Office of Technology Assessment, 1987.

Table 8.—U.S. Computer and Related Equipment Sales to China (in thousands of dollars)

Item	1981	1982	1983	1984	1985
Analog and hybrid computers	163	5,041	1,715	2,082	6,767
Digital computers	5,168	11,337	11,324	25,265	80,062
Digital central processing units	5,179	2,169	10,816	32,494	35,411
Random access auxiliary storage	1,052	1,049	1,849	1,519	7,399
Serial access auxiliary storage	140	430	680	1,995	5,204
Terminals	699	1,108	2,241	2,261	3,900
Printers	645	626	1,063	1,814	3,454
Communications and peripherals	268	1,644	2,301	8,006	9,175
Parts	3,763	8,376	11,913	20,476	31,710
Microprocessor integrated circuits	104	25	4	50	47
Printed circuit boards	258	58	557	1,407	2,245
Cathode ray tubes	8	91	22	179	417

SOURCE: Office of Chinese Affairs, U.S. Department of Commerce, 1986.

nificant. Noteworthy is that in most categories of computer and related equipment sales to China, U.S. sales from the early 1980s to the present have steadily increased. The experiences of three U.S. firms—IBM, Wang, and Foxboro—which represent different approaches and goals in technology transfer to China, are presented below.

IBM China

IBM's approach to the Chinese market up until now has emphasized sales, not technology transfer.[93] This strategy may have to change soon, however, since the Chinese have become less willing to import microcomputers directly without any explicit technology transfer element. Each year since 1980, IBM has been able to sell 20-25 mainframe systems to China. In addition, several thousand IBM personal microcomputers have made their way into China, some through direct sales, but a large number through the "gray market." IBM has also set up a training facility in China to support its sales—past, present, and future.[94]

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[93] From Denis Fred Simon, "China's Evolving Computer Industry: The Role of Foreign Technology Transfers," contractor report prepared for OTA, June 25, 1986, pp. 55-56.

[94] Among some of the U.S. computer firms that have focused on training are the following: a) IBM, which set up a training institute in Beijing as part of its sales of the IBM 5550 and other machines; b) Wang Laboratories, which set up a joint development center with the Hubei Radio Factory and a service center in Beijing; c) INTEL, which is working with the Computer Bureau of the MEI on establishment of a training center for 500-700 persons in Beijing; and d) Sperry, which is working with the China Computer Technical Services Corporation to train Chinese operators on Sperry equipment.

In many respects, IBM's success in China has had much to do with the fact that Chinese computer officials have considered IBM products (along with the Digital Equipment Corp.'s VAX series) to be one of the standards upon which to develop their own indigenous computer industry.

In 1984, IBM China was established. This gave IBM a formal Chinese presence and signalled the Chinese Government that IBM was making a long-term commitment to China. IBM China introduced to China the Model 5550, a large microcomputer that was well received not only because of its ability to handle Chinese characters efficiently, but also because its processing capabilities are far above any Chinese mass-produced machine. In 1985, IBM donated 100 of the machines to Beijing University, Qinghua University, Fudan University, and Shanghai Jiaotong University and began training classes for 40 teachers and students in operating the computers. Chinese officials would like IBM to enter into a joint venture in Guangzhou to manufacture the 5550 in China. The idea of entering into such a joint venture, however, runs counter to IBM's general approach to international marketing. Nonetheless, negotiations are continuing at this time.

Wang Joint Venture

Another U.S. computer firm that has been increasingly successful in China is Wang Laboratories, Inc.[95] Wang began doing business in China as early as 1972, though it did not really become significant until 1978-79. According to the *China Daily*, Wang has sold more than 200 small and medium-sized computers in China, most of which have been handled through its sales agreement with Instrimpex. In 1985 the company's revenues from China-related business reached more than $17 million.[96] Along with direct sales, Wang set up a small service center in Beijing in early 1984. Several months later it joined forces with the Hubei Radio Factory in Wuhan to establish a joint development center for cooperative activities in office automation, software development, and personnel training. Wang's underlying approach to China has been a strategy emphasizing sales and production of small machines, with the hope that these sales would lead to purchases of larger machines around which all of the smaller machines could be connected and networked. Its major competitive advantage in China has been its Chinese-character operating system, known as the VS (ideographic VS) system.

In 1980 Wang began negotiating with China's MEI about establishing a joint venture in China. Three proposals emerged from these discussions:

1. a joint venture with the Shanghai Computer Corporation in Shanghai;
2. a joint venture with the Xiamen Development Corporation in Fujian; and
3. a joint venture with the Beijing 738 Wire Communication Factory in Beijing.

Initially, the aim was to introduce a CKD operation for its VS system in Beijing, a CKD operation for the Wang Office Assistant in Shanghai, and a CKD operation for the IPC (ideographic professional computer) system in Xiamen. Wang was to provide the machinery and related equipment as well as cash in on setting up the production lines. The Chinese would provide the manpower, some capital investment, the buildings, and other infrastructure.

In each of the three proposed cases, Wang's major aim was to replicate its existing facilities in the United States or elsewhere. Wang's orientation in setting up joint ventures in China was to stress consistency with its proven operations. For example, in general, Wang would not bring secondhand equipment into China; nor did it anticipate introducing any drastic changes in its mode of operation. Its hope was to use capabilities at its production sites in Ireland, Scotland, Puerto Rico, Australia, Mexico, and Taiwan to assist with the startup of its China ventures. Wang expressed its willingness to provide four key forms of technology transfer: manufacturing know-how, engineering and managerial know-how, software diagnostics, and after-sales service and maintenance techniques. Moreover, Wang stressed to Chinese officials that the equipment intended for use in China was equal to that being used in the Wang facilities in Taiwan. This fact prevented a major "technology transfer issue" from emerging in the negotiations—though the issue of the value of the technology did present a stumbling block at various points in the discussions.

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[95] Taken from the OTA contractor case study "China's Evolving Computer Industry: The Role of Foreign Technology Transfers," prepared by Denis Fred Simon, June 25, 1986, pp. 57-61.

[96] "Wang Starts Computer Sales Drive," *China Daily*, Feb. 21, 1986.

A number of other issues also emerged during the course of negotiations between the two sides. First, the quantity and cost of training was a major concern to the Chinese. Wang made a special effort to define the number of people that would receive training, the tasks and areas of training, and the costs. In keeping with its policy of consistency, it offered China no more and no fewer training slots than it had given to other countries. China wanted as much training as possible.

Second, the question of foreign exchange remittance remained unsettied. It was agreed that after the third year, each venture would have an export requirement of up to 25 percent of the output. Heretofore, China's aim had been to have foreign firms hold large quantities of foreign exchange as an incentive for them to do more local sourcing and train local firms to be effective suppliers. And, while Wang prefers local sourcing and local employees, it is also concerned with four key considerations:

1. quality to meet worldwide standards, especially since the products would be using the Wang trademark;
2. overall cost competitiveness;
3. ability to meet delivery schedules; and
4. ability to meet volume requirements.

Overall, Wang's main concerns with engaging in manufacturing operations in China revolved around China's lack of familiarity with large-scale, mass production operations. Concerns existed about whether operations would ever get large enough to generate sufficient economies of scale to be profitable. Second, it was felt that local parochialism, combined with bureaucratic infighting, might continue to preclude the emergence of broad perspectives on marketing approaches. Third, Wang officials feared that China's current manufacturing techniques and philosophies might interfere with meeting quality requirements. Moreover, while the potential return on Wang's equity investment in China was of direct concern, the most pressing issue was and continues to be the cost of doing business in China until the venture matures. Under these circumstances Wang's initial strategy was to keep its ventures small while minimizing unnecessary exposure and using as few expatriates as possible to prevent a drain on the joint venture's resources.

Since initial discussion began, the three proposed projects have been restructured, owing to a variety of factors on both sides. For 1986, Wang started up its first joint venture in Shanghai. Instead of producing the Office Assistant at this site, however, the IPC is being produced. The change was necessitated because the performance of the IPC has gone up and the price has gone down, thus reducing the attraction of the earlier product. The venture has required extensive renovation of an existing facility in Shanghai. The decision to proceed first with the Shanghai venture in China was not without its problems because the MEI felt somewhat concerned about its ability to control events in that municipality. The bureaucratic rivalry between MEI and Shanghai was not something that could be easily dissipated. Nonetheless, in the interest of time, and after taking existing technical capabilities into consideration, MEI acquiesced.

Foxboro Joint Venture

The Foxboro Company of Foxboro, Massachusetts, a world leader in process control technology,[97] knew that China had extensive process control needs and thus could represent a large market for its products.[98] Foxboro officials felt that an effective strategy for penetrating the Chinese market would require a long-term commitment to operations in China and a willingness to transfer its technology. From the Foxboro perspective, cooperation with China in the production of process control equipment in China would be part of a larger corporate strategy. Having visibility and a reliable presence in China, it was thought, would facilitate sales to China from Foxboro directly, from Foxboro's other overseas affiliates, and from the vendors of large process industry equipment who would incorporate Foxboro controls into larger systems. This strategy has had some success. Quite apart from the question of the profitability of the joint venture in China, sales to China from Foxboro's European operations, for instance, have been worth US$10 million in recent years.

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[97] Process control technology generally involves regulation of industrial process temperatures, pressures, flow rates, etc. to maximize efficient production and maintain quality of the product. This is accomplished by connecting sensors (which measure the state of the system) to computers (which are preprogrammed or use adaptive optimal control algorithms) which then feedback to properly adjust the process.

The convergence of Chinese and American interests led to the establishment of one of the first joint ventures under China's new joint venture law, Shanghai-Foxboro Company Limited (SFCL), in April 1982.[99] The partners in the joint venture are the Foxboro Company and the Shanghai Instrumentation Company (SIC), a company under the Shanghai Instrumentation and Electronics Bureau of the Shanghai City government. The joint venture, the first involving the transfer of high technology, has attracted much attention, and was chosen as a site for President Reagan to visit during his 1984 trip to China.

The Foxboro-China connection began in 1975 when a team from Foxboro's Singapore and British affiliates presented a technical seminar in China that led to sales.[100] In 1978 a Chinese delegation composed of representatives of the Shanghai Instrumentation and Electronics Bureau (SIEB), the Bureau of the Instrumentation Industry of the Ministry of Machine Building, and the then Ministry of Foreign Trade visited Foxboro headquarters in Massachusetts. Three exploratory visits to China by Foxboro personnel followed in the 1979-81 period.[101] Negotiations during this period resulted in the signing of preliminary agreements in support of a joint venture. A contract establishing the joint venture was signed in 1982 with the SIC, but it also had to be approved in Beijing.[102] Subsequently, as problems arose, there was uncertainty as to which Chinese party had responsibility.[103]

Foxboro credits its affiliate in Singapore with the early vision and initiative to involve Foxboro in China. But the SFCL case is also one where the Chinese took a great deal of initiative early in the process. The Bureau of the Instrumentation Industry of the Ministry of Machine Building knew that China had process control needs that could only be met in the short run with foreign help. In addition to going to Foxboro, the Chinese also visited other companies in the United States and Japan (Honeywell, Bailey, Fisher Control, YEW, Yamataki-Honeywell). According to the Chinese management of SFCL, the Japanese were interested only in selling products and were not willing to transfer technology.

Foxboro apparently was chosen as a partner for the following reasons: First, the Chinese believed that Foxboro would be willing to transfer technology that was up to world standards. This had been the company practice in its other international operations. Second, Foxboro gave evidence of being interested in a long-term arrangement. This was again consistent with company practices elsewhere. And third, the Chinese believed that they would have in Foxboro not only a reliable source of technology, which they needed, but also a company with considerable technology transfer experience, which was indeed the case.

The Foxboro technology transfer position is that it is willing to transfer its advanced technology if three conditions are met: (1) there is a market for the leading edge technology; (2) its transfer is economically feasible and realistic; and (3) the joint venture is able to receive and assimilate it. With regard to the latter, the key indicator for Foxboro is the availability of manpower who not only can understand the principles of the technology, but, more importantly, have the know-how to ensure that the technical infrastructure for the technology-product testing and quality control, installation, and servicing is established and functioning.

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[98] Unless otherwise indicated, the information in this section is based upon interviews conducted in Shanghai and at Foxboro headquarters in Foxboro, Massachusetts by OTA staff.

[99] See Yao Jianguo, "High-Tech Success Against the Odds," *Beijing Review*, No. 46, Nov. 17, 1986, pp. 17-19.

[100] *Intertrade*, June 1984, p. 46-47.

[101] These seminars and visits, as mentioned earlier in the General Electric locomotive case study, can be a very effective means of informal technology transfer which, in certain cases, has the potential of leading to more formal agreements and contracts.

[102] Ibid.

Other important aspects of this technology transfer experience were site visits and training. There had been approximately 100 trips to Foxboro, involving 40 individuals, as of January 1986. In addition, there had been some 40,000 person-hours of training at the Shanghai facility.[103]

The joint venture is now considered relatively successful.[104] However, during its first 6 months, there were many disappointments. The Chinese in particular believed that progress was not fast enough and kept asking, "When are you going to start making computers?" The Foxboro position was (and is) that the Chinese should "learn to walk before learning to run." Thus, Foxboro insisted that the technology transfer start with simple tasks such as the soldering of circuit boards.

A number of important factors pertain to the assimilation of this technology. One is the availability of technical manpower. SFCL employs 328 people (up from 287 at the beginning of the joint venture), of whom 120 are reported to be engineers. This is an exceptionally high proportion of technical manpower for a Chinese enterprise. This relative abundance is a measure of the commitment of the Government to the joint venture and to the importance of the process industry. Nevertheless, the Chinese management of SFCL believes that the lack of trained personnel is one of the more important limiting factors on the company. The U.S. management does not seem to be as concerned about this constraint as it is about others.

A second factor is the Chinese supply system and the local availability of inputs for manufacturing. In the Foxboro view, localization is proceeding too slowly. The mentality of solving supply problems through vertical integration, a legacy of the Soviet-style economy, is deeply entrenched and biases solutions to the supply problem in the wrong direction. In addition, the Chinese supplier industries are not seeking the right technologies. The Chinese continue to resist the kind of specialization that would lead firms to seek product niches and search for the right technologies to achieve some sort of comparative advantage.

Another type of assimilation problem is the difference in language and culture. The language problem was attacked early with the preparation of an English-Chinese process control glossary. The time and effort spent in compiling this glossary has been most worthwhile from the Foxboro perspective. There are now standardized meanings for the technical terms associated with the technology, and these have made possible the avoidance of much confusion. The cultural differences may be harder to deal with, especially the risk aversion which the American managers perceive among the Chinese at the middle and lower ranks.

According to Foxboro, there were also export control problems at the outset, which the Chinese partners resented. The problem with the U.S. Government was largely an educational one; much effort was required to inform the Government of what was anticipated in Foxboro's operations in China. The Government had concerns about the computer embedded in the process control equipment and about networking capabilities that might be transferred. Some of the components used in the system were also an issue, and there were licensing delays until Foxboro was able to demonstrate that the computer in the system was technically "dedicated" to process control use.

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[103] *Intertrade*, June 1984, p. 47.

[104] Its business reached $7.5 million in 1986, a 37 percent increase over 1985. It has been in operation for four years, and in that time the company has sold 140 sets of automatic-control apparatus and meters to power-generating stations and petrochemical and metallurgical plants in China. It plans to put three new products into production in 1987. ("Electrical Joint Venture with U.S. Reports Growth," *Xinhua*, Jan. 31, 1987.)

The liberalization of U.S. export controls for sales to China in 1983 facilitated the introduction of digital technology to SFCL.

The relative success of SFCL is due to a number of factors. Foxboro is a well-run company with a highly regarded product and considerable technology transfer experience. Its technology is in great demand in China and has a strategic importance for Chinese modernization. The initiative for cooperation with Foxboro came from a powerful ministry, and the joint venture seems to enjoy high-level political support, as indicated, for instance, by SFCL's ability to recruit a high proportion of educated technical manpower. Top Chinese managers of SFCL were involved with the project from the beginning, and Foxboro's establishment of the special China team seems to have been important.

From the Foxboro perspective, one of the key questions for the future of technology transfer is whether the Chinese will become more imaginative in problem solving, more creative, and less risk averse. The Chinese still focus too much on the more advanced technology. Foxboro has introduced the Fox 300, a digital machine, into China but has not made it the focus of its technology transfer activities. Instead, the Foxboro efforts have centered on the transfer and assimilation of the Spec 200, an analog machine. Foxboro believes that the Chinese should concentrate on mastering the technology of the Spec 200, which is quite suitable for their needs, but the Chinese are still fascinated with the 300.

The Role of the Small-to-Medium-Size Firm

Heretofore, it has appeared that most firms involved in the Chinese market have been large in terms of overall personnel, earnings, and sales. The costs of doing business in China, including long negotiations, frequent trips to China, and the hosting of numerous Chinese delegations to the United States, is prohibitive for many small companies. Nonetheless, analysis of the American business presence in China reveals the participation of an appreciable number of small-to-medium-size firms (firms with less than US$100 million in annual sales). While few of these smaller firms have made direct equity investments in China, they have been able to engage in a broad range of activities in China, including technology transfer, services, direct sales, and training.

In a survey commissioned by OTA, it was found that among the smaller U.S. firms involved in the China market, most tend to be driven by short-term prospects and immediate sales opportunities; only among larger firms was the long-term perspective part of a strategic orientation toward the Chinese market.[105] Interestingly, however, many of the smaller firms involved in China have also had a significant number of other international business relationships, thus suggesting that "going international" was not new to them. Moreover, despite the difficulties associated with doing business in China, the smaller companies seemed prepared to expand their level of activity wherever possible.

Smaller firms seem to have many advantages for doing business in China. First, their size provides them with greater flexibility to respond to China's changing economic and technology needs. These firms tend to have a greater ability to pursue a market niche strategy in China, carving out a very specialized place in the midst of increasingly strong competition from both other U.S. firms and foreign companies. Second, within these firms themselves, it is often easier to reach a decision on a Chinese business proposal. And third, because of their relatively smaller scale, these firms are willing to handle a series of smaller sales and related business transactions. According to the survey, because of these factors, a number of respondents indicated that over time small firms may have a better chance of succeeding in China than their larger competitors.

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[105] "Survey on Transfer of Technical and Scientific Information and/or Sales to the People's Republic of China," administered for OTA by the Midwest China Center during November 1986 (app. 9, vol. II).

The most significant problems encountered by small firms had to do with the length of the negotiation process and the process by which their contacts with China were initiated. Most firms, large and small, tended to underestimate the time needed to complete a negotiation. Because of their size and personnel constraints, smaller firms tend to encounter significant opportunity costs when they have to send one or two of their key technical or managerial personnel to China for extended periods. They also felt that they were at a disadvantage because their size usually precluded the opening of a permanent office in China to represent the company and market its products. Only 35 percent of the small firms had some sort of office or representation in China, in contrast to 64 percent of the large firms.

The business people surveyed felt that export control procedures did affect their ability to compete with firms from other nations. One large firm has four full-time professionals and five secretaries working on licensing regulations while another uses a total of eight people—all of which adds to the cost of the product. When asked whether U.S. Government export control procedures had substantially affected their business with China, approximately one-quarter of the respondents said yes, one-half said no, and the remainder said that export controls were not applicable to their line of business with China. Suggestions for improvement of export controls included regulatory personnel with the proper technical background. At present many are not able to understand a complex technology and lack the insight to judge its relevance to military applications. In addition, many take a rigid approach to interpreting the rules regarding technology.

Many firms commented about their need for more and better information about China and the Chinese market both before and after they began business activities in China. In particular, they stressed the need for additional information about decision making in China. Generally, they felt dissatisfied with the quality of the information and support being provided by U.S. Government agencies as well as by the respective State agencies responsible for international business promotion. Trade shows were cited as a more useful mechanism for obtaining needed information, as were private consultants, though locating appropriate consultants was difficult.

Among the small-to-medium-size firms, there does not seem to be a particular pattern emerging with respect to their industrial or technological orientation. Both high-technology and standard technology firms are involved in China. For example, in a sample of such firms conducted by the Office of Domestic Operations of the U.S. and Foreign Commercial Service, Department of Commerce, the industries covered included everything from computer software, advanced laboratory analysis equipment, and cardiac monitoring equipment to providing coal analysis, ice cream production know-how, and the transfer of hog confinement techniques and related equipment.

GOVERNMENT AND INSTITUTIONAL TECHNOLOGY TRANSFER

The U.S. Government-Supported Programs

Right after the establishment of diplomatic relations in 1979, President Carter and Deng Xiaoping signed the landmark document "Agreement on Cooperation in science and technology" in Washington, D.C. This accord is the major bilateral Science and Technology program between the United States and China and provides the umbrella under which subsequent scientific, technological, and educational exchanges have occurred.[106] It covers a wide range of activities, including educational ex-

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[106] *A Relationship Restored: Trends in U.S.-China Educational Exchanges, 1978-1984* (Washington, DC: National Academy Press, 1986), p. 62.

Photo credit: Eric O. Basques

The Dalian Management Institute (The National Center for Industrial Science and Technology Management Development) located at the Dalian Institute of Technology was established in accordance with the US-PRC Science and Technology Protocols. It is jointly sponsored by the State Economic Commission, the State Science and Technology Commission and the Mininstry of Education on the Chinese side and by the Department of Commerce on the U.S. side. This highly successful management training program started in 1980.

change, space technology, high-energy physics, earthquake studies, and telecommunications. The earliest agreements started in 1978-79, with new ones being added periodically. The active agreements and some pending ones as of June 1986 are listed in Appendix B.

There are two overarching U.S.-China commissions that have fundamental responsibility for establishing the basis for U.S.-China economic cooperation. The U.S. Treasury Department is represented on the Joint Economic Commission, whereas the Department of Commerce is the U.S. representative on the Joint Commission for Commerce and Trade. Both commissions have interests in technology transfer arrangements.

Other programs in China are the Fulbright Program and the activities of the National Science Foundation. The Committee on Scholarly Communication with the People's Republic of China (CSCPRC) has also been active in this arena since its founding in 1966 under the joint sponsorship of the American Council of Learned Societies, the National Academy of Sciences (NAS), and the Social Science Research Council. The CSCPRC is designated to administer the National Program for Advanced Research and Study in China. In addition to this national program they have also run the reciprocal "Distinguished Scholar Exchange Program" since 1979.

Bilateral Agreements

The number of bilateral accords in science, technology, or education between Chinese and U.S. Government agencies grew from 2 to 26 between 1978 and 1986. It was felt that giving major government agencies in each country a stake in improved U.S.-China relations would help institutionalize the Sino-American relationship more rapidly. Appendix B shows that the agreements cover a broad range of scientific areas, including: agriculture, space technology, high-energy physics, medicine and public health, earthquake studies, aeronautics, management, nuclear safety, transportation, and telecommunications. Activities under most of these agreements are funded under existing agency budgets, not through special appropriations. Thus these agreements have led to varying degrees of activity, depending on agency priorities.

As of 1985, some of the most intensive activity was under the aegis of the protocols on atmospheric science and technology, marine and fishery science and technology, the earth sciences, earthquake studies, and management of industrial science and technology (under which the Dalian Management Center was set up). Interactions under the 1979 "Understanding on Agricultural Exchange" were extensive until November 1983, when activities were suspended because China did not import the quantity of U.S. grain called for in a long-term agreement.[107] Activities under this exchange have recently resumed, however.

Under the auspices of the United States-China Accord on Industrial and Technological Cooperation, the Department of Commerce and China's Ministry of Foreign Economic Relations and Trade have developed a series of work programs that target U.S. Government trade and investment promotion activities and U.S. private sector interests on priority development projects. Work programs exist in aerospace, electronics and telecommunications, machine building, metallurgy, and building materials.

Student Exchange

Included in the U.S.-China science and technology agreement was the previous "Understanding on Educational Exchanges," signed in October 1978, which provided for the exchange of undergraduate students, graduate students, and visiting scholars to undertake research and study in each country.

During the 1985-86 academic year, about 17,000 Chinese students and professors were enrolled in U.S. universities, mostly in graduate programs of science and engineering.[108] Nationwide, Chinese students were the 11th largest group of foreign students in the United States during the 1984-85 school year, behind Taiwan, Malaysia, Nigeria, Iran, South Korea, Canada, India, Japan, Venezuela, and Hong Kong.[109]

Most of the Chinese students coming to the United States under the revived U. S.-China educational exchange program have been concentrated heavily in science and other technical disciplines. Over two-thirds of those sponsored by the Government were in the physical, life, health, or computer sciences, mathematics, and engineering.

About one-half of all Chinese students and scholars sent abroad come to the United States.[110] The rapid buildup in the numbers of students and scholars coming to the United States is said to have made the exchanges an important element in China's effort at modernization.[111] How effectively these students' skills are used when they return to China is open to debate.[112] Most would agree, however, that Chinese students regard their studies in the United States favorably.[113]

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[107] Ibid., p. 64.

[108] Chinese Embassy, Washington, DC, 1986.

[109] Institute of International Education in New York, figures quoted in the *Philadelphia Inquirer*, Andrew MayKuth, "Chinese Students Soak Up Technology to Take Back Home," July 4, 1986, p. 1B.

[110] The number of U.S. students and scholars going to China under the exchanges has been smaller and in different academic fields. An estimated 3500 Americans participated in exchanges from 1978 through 1984 with a majority pursuing short-term language study. Of those who performed research, two-thirds were in the social sciences and humanities.

[111] *A Relationship Restored: Trends in U.S.-China Educational Exchanges, 1978-1984* (Washington, DC: National Academy Press, 1986), p. 62.

Statistics on Chinese students in the United States are very uncertain but about one-third of the students have been financed by relatives who live outside of China. However, China may have decided to foreclose this approach.[114] The majority of the students are funded by grants from the Chinese Government. Increasingly, the Chinese Government funds students for only the first year abroad and expects them to find financial aid to complete their training.[115] The U.S. Government does not allow foreign students into the country unless they can prove that they have adequate funds. In addition, acceptance of a nonimmigrant exchange visitor visa may, in certain circumstances, subject the holder to a 2-year foreign repatriation requirement upon termination of status.[116] The Chinese Government's official position is that only those students who accept grants from the Chinese Government are required to return.[117] The Chinese students generally do want to return. In the few cases where they sought to stay, however, the Chinese have exerted tremendous diplomatic pressure.[118]

Private Programs

U.S. company support for technology transfer through training has been demonstrated in several instances. One example with great future potential is the Telecommunications Training Institute, where training of developing country telecommunications specialists is performed on U.S. company premises. Of a different nature is a large university-industry collaboration between China and the Georgia Institute of Technology called China/Tech. This is a Chinese-American joint venture between Technology Exchange Corp., a private company in Atlanta, and the Technology Clearinghouse of China, a Chinese corporation wholly owned by and operated under the guidance of CAST (Chinese Association for Science and Technology). China/Tech will provide a wide range of consulting services to U.S. companies that are interested in setting up new ventures or in licensing technology to China. The entire Georgia Tech staff is available for consulting services, and the 1.4 million Chinese scientists and engineers who are members of CAST will keep China/Tech apprised of China's modernization efforts.[119]

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[112] See for example, Leo A. Orleans, "Chinese Students and Technology Transfer," *Journal of Northeast Asian Studies*, vol. IV, No. 4, winter 1985, p. 3 ff.

[113] This establishment of "personal ties" could be influential in future U.S.-China economic relations. Chinese students trained in the United States are absorbing preferences for U.S. technology and equipment which may help perpetuate the apparent Chinese preference for U.S. technology.

[114] Leo A. Orleans, personal communication, June 1987.

[115] Ibid.

[116] *Foreign Nationals in the United States—Information Guide*—1986 Edition, Price Waterhouse Center for Transnational Taxation, New York, pp. 62-63.

[117] The Chinese say that they have sent more than 30,000 students overseas at state expense since 1978. So far about half of them have completed their courses and returned to China. However, of those who went at their own expense, 40 percent of all students abroad, only a small number returned. ("Study Abroad: No Panic," *Beijing Review*, vol. 30, No. 2, Jan. 12, 1987, pp. 6-7.)

[118] *Philadelphia Inquirer*, op. cit.

[119] Otis Port, "Georgia Tech Has China On Its Mind," *Business Week*, Mar. 31, 1986, p. 70H.

CONCLUSION

The Chinese have targeted the energy, transportation, and communications technology sectors as priority areas in their most recent 5-year plan. Large-scale technology transfer from industrialized countries is essential for China's continued economic development. Areas of foreign expertise likely to be in greatest demand thus include conventional and nuclear electric power production, automobile technology, rail technology, telephone switching systems, fiber optics, and computers. Management expertise is also a critical need for the Chinese.

The investment climate in China remains unattractive for many U.S. companies, and any changes will come slowly. However, as the Chinese reforms proceed and new benchmarks are established, the investment climate will probably improve. This is because the Chinese realize that the degree to which China accomplishes its modernization goals will depend on the importation and application of advanced technologies throughout the economy. Prospects for joint ventures may improve since the foreign investment law of October 11, 1986 was codified with 16 sets of detailed implementing regulations covering specific investor concerns in March 1987. Also, despite specific problems of their own (usually involving proprietary rights or foreign exchange), licensing agreements will continue to be a common mode of technology transfer for foreign companies, particularly since the Chinese have apparently agreed to honor patent conventions. If the patience and perseverance of U.S. firms can be matched by Chinese pragmatism, U.S. ventures in the Chinese market can truly become those of "equality and mutual benefit."

APPENDIX A: PROVISIONS OF THE STATE COUNCIL OF THE PEOPLE'S REPUBLIC OF CHINA FOR THE ENCOURAGEMENT OF FOREIGN INVESTMENT (PROMULGATED ON OCTOBER 11, 1986)

Article 1. These provisions are hereby formulated in order to improve the investment environment, facilitate the absorption of foreign investment, introduce advanced technology, improve product quality, expand exports in order to generate foreign exchange, and develop the national economy.

Article 2. The State encourages foreign companies, enterprises, and other economic entities or individuals (hereinafter referred to as "foreign investors") to establish Chinese-foreign equity joint ventures, Chinese-foreign cooperative ventures and wholly foreign-owned enterprises (hereinafter referred to as "enterprises with foreign investment") within the territory of China.

The State grants special preferences to the enterprises with foreign investment listed below:

- production enterprises whose products are mainly for export, which have a foreign exchange surplus after deducting from their total annual foreign exchange revenues the annual foreign exchange expenditures incurred in production and operation and the foreign exchange needed for the remittance abroad of the profits earned by foreign investors (hereinafter referred to as "export enterprises"); and
- production enterprises possessing advanced technology supplied by foreign investors which are engaged in developing new products, and upgrading and replacing products in order to increase foreign exchange generated by exports or for import substitution (hereinafter referred to as "technologically advanced enterprises").

Article 3. Export enterprises and technologically advanced enterprises shall be exempt from payment to the State of all subsidies to staff and workers, except for the payment of or allocation of funds for labor insurance, welfare costs, and housing subsidies for Chinese staff and workers in accordance with the provisions of the State.

Article 4. The site use fees for export enterprises and technologically advanced enterprises, except for those located in busy urban sectors of large cities, shall be computed and charged according to the following standards:

- five to twenty RMB yuan per square metre per year in areas where the development fee and the site use fee are computed and charged together, and
- not more than three RMB yuan per square metre per year in site areas where the development fee is computed and charged on a one-time basis or areas which are developed by the above-mentioned enterprises themselves.

Exemptions for specified periods of time from the fees provided in the foregoing provision may be granted at the discretion of local people's governments.

Article 5. Export enterprises and technologically advanced enterprises shall be given priority in obtaining water, electricity and transportation services, and communication facilities needed for their production and operation. Fees shall be computed and charged in accordance with the standards for local state enterprises.

Article 6. Export enterprises and technologically advanced enterprises, after examination by the Bank of China, shall be given priority in receiving loans for short-term revolving funds needed for production and distribution, as well as for other needed credit.

Article 7. When foreign investors in export enterprises and technologically advanced enterprises remit abroad profits distributed to them by such enterprises, the amount remitted shall be exempt from income tax.

Article 8. After the expiration of the period for the reduction of exemption of enterprise income tax in accordance with the provisions of the State, export enterprises whose value of export products in that year amounts to 70 percent or more of the value of their products for that year, may pay enterprise income tax at one-half the rate of the present tax.

Export enterprises in the special economic zones and in the economic and technological development zones and other export enterprises that already pay enterprise income tax at a tax rate of 15 percent and that comply with the foregoing conditions, shall pay enterprise income tax at a rate of 10 percent.

Article 9. After the expiration of the period of reduction or exemption of enterprise income tax in accordance with the provisions of the State, technologically advanced enterprises may extend for 3 years the payment of enterprise income tax at a rate reduced by one half.

Article 10. Foreign investors who reinvest the profits distributed to them by their enterprises in order to establish or expand export enterprises or technologically advanced enterprises for a period of operation of not less than 5 years, after application to and approval by the tax authorities, shall be refunded the total amount of enterprise income tax already paid on the reinvested portion. If the investment is withdrawn before the period of operation reaches 5 years, the amount of enterprise income tax refunded shall be repaid.

Article 11. Export products of enterprises with foreign investment, except crude oil, refined oil, and other products subject to special State provisions, shall be exempt from the consolidated industrial and commercial tax.

Article 12. Enterprises with foreign investment may arrange the export of their products directly or may also export by consignment to agents in accordance with State provisions. For products that require an export license, in accordance with the annual export plan of the enterprise, an application for an export license may be made every six months.

Article 13. Machinery and equipment, vehicles used in production, raw materials, fuel, bulk parts, spare parts, machine component parts and fittings (including imports restricted by the State), which enterprises with foreign investment need to import in order to carry out their export contracts do not require further applications for examination and approval and are exempt from the requirement for import licenses. The customs department shall exercise supervision and control, and shall inspect and release such imports on the basis of the enterprise contract or the export contract.

The imported materials and items mentioned above are restricted to use by the enterprise and may not be sold on the domestic market. If they are used in products to be sold domestically, import procedures shall be handled in accordance with provisions and the taxes shall be made up according to the governing sections.

Article 14. Under the supervision of the foreign exchange control departments, enterprises with foreign investment may mutually adjust their foreign exchange surpluses and deficiencies among each other.

The Bank of China and other banks designated by the People's Bank of China may provide cash security services and may grant loans in Renminbi to enterprises with foreign investment.

Article 15. The people's governments at all levels and relevant departments in charge shall guarantee the right of autonomy of enterprises with foreign investment and shall support enterprises with foreign investment in managing themselves in accordance with international advanced scientific methods.

With the scope of their approved contracts, enterprises with foreign investment have the right to determine by themselves production and operation plans, to raise funds, to use funds, to purchase production materials, and to sell products; and to determine by themselves the wage levels, the forms of wages and bonuses, and the allowance system.

Enterprises with foreign investment may, in accordance with their production and operation requirements, determine by themselves their organizational structure and personnel system, employ or dismiss senior management personnel, and increase or dismiss staff and workers. They may recruit and employ technical personnel, managerial personnel, and workers in their locality. The unit to which such employed personnel belong shall provide its support and shall permit their transfer. Staff and workers who violate the rules and regulations, and thereby cause certain bad consequences may, in accordance with the seriousness of the case, be given differing sanctions, up to that of discharge. Enterprises with foreign investment that recruit, employ, dismiss, or discharge staff and workers, shall file a report with the local labour and personnel department.

Article 16. All districts and departments must implement the "Circular of the State Council Concerning Firmly Curbing the Indiscriminate Levy of Charges on Enterprises." The people's governments at the provincial level shall formulate specific methods and strengthen supervision and administration.

Enterprises with foreign investment that encounter unreasonable charges may refuse to pay and may also appeal to the local economic committees up to the State Economic Commission.

Article 17. The people's governments at all levels and relevant departments in charge shall strengthen the co-ordination of their work, improve efficiency in handling matters and shall promptly examine and approve matters reported by enterprises with foreign investment that require response and resolution. The agreement, contract and articles of association of an enterprise with foreign investment shall be examined and approved by the departments in charge under the State Council. The examination and approval authority must within three months from the date of receipt of all documents decide to approve or not to approve them.

Article 18. Export enterprises and technologically advanced enterprises mentioned in these provisions shall be confirmed jointly as such by the foreign economic relations and trade departments where such enterprises are located and the relevant departments in accordance with the enterprise contract, and certification shall be issued.

If the actual results of the annual exports of an export enterprise are unable to realize the goal of the surplus in the foreign exchange balance that is stipulated in the enterprise contract, the taxes and fees which have already been reduced or exempted in the previous year shall be made up in the following year.

Article 19. Except where these provisions expressly provide that they are to be applicable to export enterprises or technologically advanced enterprises, other articles shall be applicable to all enterprises with foreign investment.

These provisions apply from the date of implementation to those enterprises with foreign investment that have obtained approval for establishment before the date of implementation of these provisions and that qualify for the preferential terms of these provisions.

Article 20. For enterprises invested in and established by companies, enterprises, and other economic organizations or individuals from Hong Kong, Macao, or Taiwan, matters shall be handled by reference to these provisions.

Article 21. The Ministry of Foreign Economic Relations and Trade shall be responsible for interpreting these provisions.

Article 22. These provisions shall go into effect on the date of issue.

SOURCE: *Beijing Review*, No. 43, Oct. 27, 1986.

APPENDIX B: PROTOCOLS AND MEMORANDA OF UNDERSTANDING UNDER THE U.S.-PRC AGREEMENT ON COOPERATION IN SCIENCE AND TECHNOLOGY

1. Agreement: Understanding on Exchange of Students and Scholars
Date signed: October 1978, Exchange Letter of January 1979
Date extended: Unlimited
U.S. agency: USIA, DOE, NSF, NAS, NEH
Chinese unit: MOE, CASS, SSTC

2. Agreement: Understanding on Agricultural Exchange
Date signed: November 1978
Date extended: Unlimited
U.S. agency: USDA, USGS, and DOI/Fish and Wildlife Service
Chinese unit: Ministry of Agriculture, Animal Husbandry, and Fisheries

3. Agreement: Understanding on Space Technology (overall protocol on Space Science Application and Technology currently under negotiation)
Date signed: January 31, 1979
Date extended: Unlimited
U.S. agency: NASA
Chinese unit: Chinese Academy of Space Technology (under the Ministry of Astronautics) and CAS

4. Agreement: Implementing Accord on Cooperation in the Field of High Energy Physics
Date signed: January 31, 1979
Date extended: February 1984
U.S. agency: February 1989
Annexes and dates: Annex June 12, 1979, Joint Committee Reports 1979-1980, 1980-1981, 1982-1983
U.S. agency: DOE
Chinese unit: CAS (formerly signed with SSTC)

5. Agreement: Protocol on Cooperation in the Field of Metrology and Standards
Date signed: May 8, 1979

Date extended: May 8, 1984
Date expired: May 8, 1989
Annexes and dates: Annex (1) May 8, 1979; Annex (2), May 5, 1981 (supersedes Annex (1). (Annexes do not apply to extension.)
U.S. agency: DOC (National Bureau of Standards)
Chinese unit: State Bureau of Metrology and State Bureau of Standardization

6. Agreement: Protocol on Cooperation in the Field of Atmospheric Science and Technology
Date signed: May 8, 1979
Date extended: May 1984
Date expires: May 1989
Annexes and dates: Annex (1), May 1979; Annex (2), May 1979; Annex (3), September 1980; Annex (4), September 1980; Annex (5), November 1981; Annex (6), November 1981
U.S. agency: NOAA, NSF, NASA, USDA
Chinese unit: State Meteorological Administration

7. Agreement: Protocol on the Field of Marine and Fishery Science and Technology
Date signed: May 8, 1979
Date extended: May 1984
Date expires: May 1989
Annexes and dates: Annex (1), May 1979; Annex (2), Working Group Meeting 1980; Annex (3), Working Group Meeting 1982; Annex (4), Working Group Meeting 1984
U.S. agency: NOAA, NSF
Chinese unit: National Bureau of Oceanography and Ministry of Agriculture, Animal Husbandry and Fisheries

8. Agreement: Protocol on Cooperation in the Sciences and Technology of Medicine and Public Health
Date signed: June 22, 1979
Date extended: Extension under negotiation
Date expired: June 22, 1984
Annexes and dates: Annex (1), November 1980; Annex (2), November 1980; Annex (3), January 1982
U.S. agency: HHS (NIH)
Chinese unit: Ministry of Public Health

9. Agreement: Protocol on Cooperation in Hydroelectric Power and Related Water Resource Management
Date signed: August 28, 1979
Date extended: Expired; no plans for extension
Date expired: August 28, 1984
Annexes and dates: Annex (1), March 1980; Annex (2), September 1982
U.S. agency: DOC, DOI (Bureau of Reclamation, Corps of Engineers, Tennessee Valley Authority)
Chinese unit: Chinese Ministry of Water Resources and Electric Power

10. Agreement: Protocol for Scientific and Technical Cooperation in the Earth Sciences
Date signed: January 24, 1980
Date extended: January 24, 1985
Date expires: January 24, 1990
Annexes and dates: Annex (1), Patents, November 1981; Annex (2); Annex (3); Annex (4), Copyrights; Annex (5); Annex (6) Working Group Meeting 1984
U.S. agency: DOI (USGS) and NSF
Chinese unit: Chinese Academy of Geological Sciences

11. Agreement: Protocol for Scientific and Technical Cooperation in Earthquake Studies
Date signed: January 24, 1980
Date extended: January 24, 1985
Date expires: January 23, 1990
Annexes and dates: Annexes (1-8)
U.S. agency: USGS and NSF
Chinese unit: Chinese State Seismological Bureau

12. Agreement: Protocol for Scientific and Technical Cooperation in the Field of Environmental Protection
Date signed: February 5, 1980
Date extended: February 1985
Date expires: February 1989
Annexes and dates: Annexes (1-3)
U.S. agency: Environmental Protection Agency
Chinese unit: Office of the Environmental Protection Leading Group

13. Agreement: Protocol on Cooperation in the Basic Sciences
Date signed: December 10, 1980
Date expired: December 1985
Annexes and dates: Annex (1), Patents and Copyrights, March 1981
U.S. agency: NSF
Chinese unit: CAS and CASS

14. Agreement: Protocol on Cooperation in the Field of Building Construction and Urban Planning Science and Technology
Date signed: October 17, 1981
Date expires: October 1986
Annexes and dates: Annex (1)
U.S. agency: Department of Housing and Urban Development
Chinese unit: Ministry of Urban and Rural Construction and Environmental Protection

15. Agreement: Protocol on Cooperation in Nuclear Safety Matters
Date signed: October 17, 1981
Date expires: October 1986
U.S. agency: NRC
Chinese unit: National Nuclear Safety Administration (formerly SSTC)

16. Agreement: Protocol on Scientific and Technical Cooperation in the Study of Surface Water Hydrology
Date signed: October 17, 1981
Date expires: October 1986
Annexes and dates: Annexes (1-4), 1983; Annexes (5-6), 1985
U.S. agency: DOI (USGS)
Chinese unit: Bureau of Hydrology (under the Ministry of Water Conservancy)

17. Agreement: Cooperation in the Fields of Nuclear Physics and Controlled Magnetic Fusion Research
Date signed: May 11, 1983
Date expires: May 1988
Annexes and dates: Annexes (1-5), 1985
U.S. agency: DOE
Chinese unit: SSTC

18. Agreement: Cooperation in Aeronautical Science and Technology
Date signed: May 11, 1983
Date expires: May 1988
Annexes and dates: Annex (1), Copyrights, April 5, 1985; Annex (2), April 5, 1985
U.S. agency: NASA
Chinese unit: Chinese Aeronautical Establishment (under the Ministry of Aeronautics)

19. Agreement: Protocol on Cooperation in Science and Technology of Transportation
Date signed: May 11, 1983
Date expires: May 1988
U.S. agency: Department of Transportation
Chinese unit: Ministry of Communications

20. Agreement: Protocol on Cooperation in the Field of Scientific and Technical Information
Date signed: May 8, 1979
Date extended: April 30, 2984

Date expires: April 1989
Annexes and dates: Annex (1); Annexes (2-4), February 8, 1982
U.S. agency: DOC (NTIS)
Chinese unit: ISTIC (under SSTC)

21. Agreement: Cooperation in the Field of Management of Industrial Science and Technology
Date signed: May 1979
Date extended: April 1984
Date expires: April 1989
U.S. agency: DOC
Chinese unit: State Economic Commission, SSTC, MOE

22. Agreement: Protocol on Cooperation in Statistics
Date signed: July 24, 1984
Date expires: July 1989
U.S. agency: DOC (Bureau of the Census)
Chinese unit: State Statistical Bureau

23. Agreement: Memorandum of Understanding on Cooperation in the Basic Biomedical Sciences
Date signed: May 11, 1983
Date expires: May 1988
U.S. agency: NIH
Chinese unit: CAS

24. Agreement: Protocol for Scientific and Technical Cooperation in Surveying and Mapping Studies
Date signed: April 16, 1985
Annexes and dates: Annex (1), 1985
U.S. agency: USGS/Defense Mapping Agency
Chinese unit: National Bureau of Surveying and Mapping (under SSTC)

25. Agreement: Protocol on Cooperation in the Field of Fossil Energy Research and Development
Date signed: April 16, 1985
Annexes and dates: Annex (1), 1985
U.S. agency: DOE
Chinese unit: Ministry of Coal Industry

Under negotiation:

1. Agreement: Landsat Ground Station Memorandum of Understanding
U.S. agency: DOC (NOAA/NESDIS)
Chinese unit: CAS

2. Agreement: Telecommunications
U.S. agency: DOC
Chinese unit: Ministry of Post and Telecommunications

3. Agreement: Health Memorandum of Understanding between the Center for Disease Control and the China National Center for Preventive Medicine
U.S. agency: HHS (PHS and CDC)
Chinese unit: China National Center for Preventive Medicine

ABBREVIATION KEY *U.S. agencies*: CDC Centers for Disease Control; DOC Department of Commerce; DOE Department of Energy; DOI Department of the Interior; HHS Department of Health and Human Services; NAS National Academy of Sciences; NASA National Aeronautics and Space Administration; NBS National Bureau of Standards; NEH National Endowment for the Humanities; NESDIS National Environmental Satellite Data and Information Service; NIH National Institutes of Health; NOAA National Oceanic and Atmospheric Administration; NRC Nuclear Regulatory Commission; NSF National Science Foundation; NTIS National Technical Information Service; PHS Public Health Service; USDA U.S. Department of Agriculture; USGS U.S. Geological Survey; USIA U.S. Information Agency.

Chinese units: CAS Chinese Academy of Sciences; CASS Chinese Academy of Social Sciences; ISTIC Institute of Science and Technology Information of China; MOE Ministry of Education; SSTC State Science and Technology Commission.

SOURCE: *A Relationship Restored: Trends in U.S.-China Educational Exchange, 1978-1984*, National Academy Press, Washington, DC, 1986.

Chapter 5

Policies of Other Supplier Countries: Japan, France, West Germany, and Britain

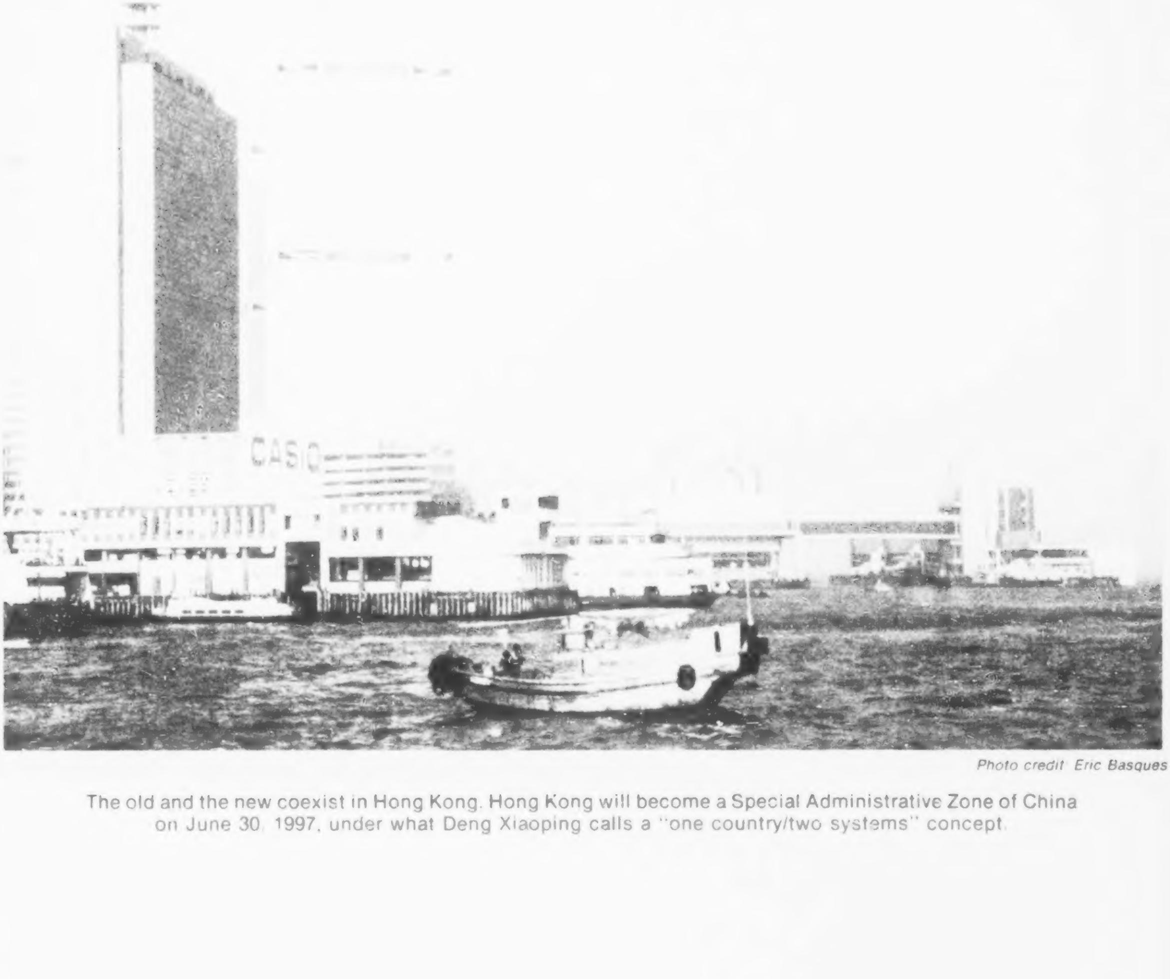

Photo credit: Eric Basques

The old and the new coexist in Hong Kong. Hong Kong will become a Special Administrative Zone of China on June 30, 1997, under what Deng Xiaoping calls a "one country/two systems" concept.

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Chapter 5

Policies of Other Supplier Countries: Japan, France, West Germany, and Britain

Japan and many European countries are actively assisting China in its modernization programs. Firms from these major supplier countries can supply virtually all the technologies that the United States can and share common Western security interests. Japanese exports to China have in recent years far exceeded those of the United States or any West European country, raising questions about U.S. export performance.

This chapter compares the approaches taken by these major supplier countries in order to identify opportunities and problems for U.S. policy. OTA finds that while competition among these countries for sale of products and technologies to China is generally a healthy process, technology transfers and trade also present policy challenges to the United States and to the Western "alliance" nations collectively. One challenge is to U.S. firms (and to the U.S. Government) to compete effectively in the China market.

Others will require complementary efforts by policymakers in the United States and the other supplier countries. An example is the need to strike a proper balance in assisting China in its modernization while preserving Western strategic interests in Asia. Maintaining this balance may entail further efforts to harmonize export control policies, a process that will increasingly depend upon the participation of other Asian countries such as Singapore. A second challenge is the need to avoid costly competition, propelled by subsidized exports, and to ensure expanded trade with China while avoiding protectionist responses. On a more positive note, there are also opportunities for cooperation in development projects that require financial and other resources so great that they would strain the capacities of any one supplier country.

FOREIGN POLICY PERSPECTIVES

Japan

Japan's official government policy today strongly supports China's economic modernization and growing economic relations. Proximity to China as well as its historic ties and technological prowess helped Japan become China's number-one trading partner. For Japan, now poised for what some see as a larger political and strategic role, China offers an unusual opportunity to contribute to the modernization of an Asian neighbor. Succeeding in this effort could reinforce Japan's growing leadership role in Asian trade and security.

Sino-Japanese economic relations developed over a bumpy path during the postwar period, however, and significant problems remain. Japanese experts refer to "political-economic" cycles in Sino-Japanese trade. Japan's exports of machinery and equipment to China show peaks during periods of improving bilateral relations and troughs coinciding with political changes such as the Cultural Revolution.[1] Japanese business and government leaders charted a pragmatic policy course that led to expanded economic interaction through unofficial channels before the warming of relations in the 1970s, but at times Chinese stress on political principles was a constraint.

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[1] Mitsubishi Sogo Kenkyujo, *Nibe Kigyo no Chugoku Shijo Akusesu to Ajia Taihai Chiiki no Kozu* [Structure and Access by Japanese and U.S. Firms to the Chinese Market], MRI Projection No. 20, May 24, 1985, p. 34.

In 1978 Japan and China opened a new era in their bilateral relationship by signing a Treaty of Peace and Friendship and a Long-Term Trade Agreement. The establishment of diplomatic relations between the United States and China in 1979 set the stage for rapidly growing Sino-Japanese interaction.[2]

Japan's foreign policy toward China is based on the proposition that contributing to China's modernization will allow China to resist Soviet influence better. China is seen as a socialist country, one quite different from the Soviet Union, which poses the greatest threat to Japan's security. While Japan would be wary of a strong military "alliance" with China that was perceived as threatening by the Soviet Union, Japan has determined that helping China modernize will contribute to China's peaceful economic and political integration into Asia. According to this view, economic and technical assistance make it more likely that China's relations with the West expand.

A number of other factors, in addition to U.S.-China rapprochement and Japan's perception of the role that China can play as a counterpower to the Soviet Union, underlie the rapid growth of economic relations since the late 1970s. In a climate of growing trade frictions with the United States and Europe, and a shrinking Middle Eastern market, China appears to hold at least a commercial prospect. China also provides a unique opportunity for Japan to demonstrate its commitment to expand its official development assistance in ways that contribute to Western security interests. The complementarity between China's energy, natural, and human resources and Japan's technological and economic acumen suggests a natural basis for economic exchange. Anxious to develop a new style of constructive leadership in Asia, Japanese government and business find in China a prime testing ground.

But despite the considerable progress that has been made in deepening Sino-Japanese ties, serious points of friction became apparent in 1985. Since the mid-1970s, when Japan established itself as China's prime trading partner, China's leaders have complained about trade deficits with Japan. For years, the two countries attempted to resolve this problem under the rubric of long-term trade agreements that featured increased Japanese commitments to import Chinese oil and coal.[3] By 1985 the trade deficit had become a prime concern in bilateral relations, as Japan's surplus reached $6 billion on a total bilateral trade basis of about $19 billion.[4] In late 1985 and early 1986, Chinese officials issued repeated warnings about the trade imbalance.[5]

Particularly noteworthy was the linkage of the trade issue to other points of controversy in the Sino-Japanese relationship. Chinese student demonstrations in late 1985 revealed resentment over Japan's trade "invasion," and Prime Minister Nakasone's unprecedented visit to a shrine to honor war dead awakened memories of Japan's earlier aggression in China. While the causes and significance of the Chinese student demonstrations remain the subject of considerable controversy, those demonstrations previewed a series of attempts by both countries to repair the points of friction. Nakasone announced a cancellation of immediate plans for a second visit to the shrine, and Chinese Communist Party leader Hu Yaobang proposed four points aimed at improving friendship, calling on the two governments to "adopt a correct approach to their serious conflicts of the past."[6]

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[2] During the early postwar period, Japan was in no position to establish an independent foreign policy. After the Korean War, worsening U.S.-China relations precluded official Sino-Japanese rapprochement. In the early 1960s, the United States and Taipei persuaded Japan not to use Export-Import Bank financing to support China trade. See Chae-Jin Lee, *China and Japan* (Stanford: Hoover Inst. Press, 1984), p. 6.

[3] Japan nevertheless registered a trade surplus with China every year since 1972, except for 1981 and 1982, when China adopted a policy of restricting imports due to financial difficulties. Neither oil nor coal exports met expectations.

[4] During 1986, Japan ran a $4.2 billion trade surplus, reflecting the fact that exports fell 18 percent below the level of the previous year, according to Japanese customs-clearance figures.

[5] In March 1986, China's Ambassador to Japan warned that China was watching the trade picture carefully and was concerned about the trade gap. In April 1986, China's Foreign Minister Wu on a visit to Tokyo called the trade deficit a big problem. China has repeatedly called upon Japan to open its doors to more imports from China and expanded investments in and technology transfer to China.

[6] See "Hu Outlines Framework for Friendship with Japan," *China Daily*, Oct. 19, 1985.

Photo credit: Xinhua News Agency

Checking integrated circuits at the Jiangnan Radio Appliance Factory in Wuxi This equipment was supplied by Japan

Quite recently, the Government of Japan apologized to China for statements made by former Minister of Education Masayuki Fujio suggesting that Japan was justified in its aggression in Nanking in 1937.[7] Thus, while the two countries have attempted to relieve tensions, deep and historic points of friction remain over Japan's past aggression and its relationship with Taiwan.[8]

Other constraints stem more from external factors. Prime among these is the need to balance growing ties with China with the desire to preserve good relations with the Association of Southeast Asian Nations (ASEAN) and other Asian countries. Hence, Japan's Foreign Ministry has developed an aid strategy explicitly founded on three principles: (1) balancing aid to China with aid to ASEAN (2) cooperating with Western countries, and (3) providing no military aid. This approach embodies Japan's response to concerns raised by the Organization for Economic Cooperation and Development (OECD) countries about growing Japanese Export-Import Bank financing for energy and other projects for developing infrastructure in China.

Japan thus has a great deal to gain if its policies toward China succeed, but its prestige and influence could be diminished if frictions over trade and technology transfer fester and reactivate older points of controversy. China, more than other developing countries in Asia, appears capable of applying pressure on Japan. Japan's growing involvement in China is, morever, being carefully watched by other countries in the region. The expanding Sino-Japanese relationship thus holds potential pitfalls as well as opportunities for Japan that extend beyond the bilateral relationship.

Europe

European countries have had centuries of trading experience with China. The value of this trade and China's internal weakness led to intense political interference, starting with the Opium War in 1839-42. The Boxer Rebellion of 1899 began a period of reaction to European imperialism that lasted until about 1920. Actual colonialism was limited to Hong Kong and Macao, but the de facto loss of control to Europe (plus the United States, to much less extent, and later to Japan) left a lasting preoccupation with national sovereignty. This experience also produced business and personal ties that have been useful in expanding trade as relations improved in recent years.

There is considerable commonality among the views of the European trading partners of

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[7] Western and Chinese historians have written about the atrocities committed by the Japanese (known as the "Rape of Nanking") after they captured Nanking in 1937. Apologies were also made to South Korea. See, e.g., John Burgess, "Japan's Education Minister Fired for Remarks about World War II," *Washington Post*, Sept. 9, 1986, p. A21.

[8] Japan ended diplomatic relations with Taiwan in 1972. Nevertheless, China raised concerns over the participation by some Liberal Democratic Party leaders in a commemoration of Chiang Kai-shek.

China. All are interested in increasing trade. Technology transfer is seen as a natural part of trade, often a crucial part, for competitive reasons. A modernized China is, if anything, seen as strategically beneficial vis-a-vis the Soviet Union. At present, there are few significant disputes between China and European countries.

This overall outlook is similar to that of the United States, but differences arise in the degree of concern over certain issues and in the ways in which policies are carried out, both at the government and corporate levels. Since there is little potential for direct strategic conflict between Europe and China, Europe is less concerned about improvements to China's military capability from dual-use technologies or direct military transfers. All members of the Coordinating Committee for Multilateral Export Controls (COCOM) use the same rules, but different interpretations of applicability to specific exports are often possible.

European trade has had its ups and downs, as with Japan, but this has been due more to China's internal economic decisions than to international political factors. The frictions that have marked China's trading relations with Japan and the United States have been much less pronounced in Europe. European countries see China as a promising commercial market that is attractive, considering their own sluggish economies, but also relatively modest for the foreseeable future. Europe's trade with China exceeds that of the United States (by a widening margin), though it is much less than Japan's.

There is less variation in perspectives on technology transfer to China among the various countries of Europe, than between Europe and the United States or Japan. No grand designs, either strategic or commercial, seem to underlie Europe's approach, and no great controversies impede the relationships. The whole issue is lower key and more matter-of-fact. Within Europe, there are differing approaches to technology transfer, as discussed below, but few disputes between countries over trade with China.

From China's perspective, the European connection offers the best of all worlds. European technology is in most respects equivalent to American or Japanese, but Europeans seem to be readier to transfer it than Americans, with their strategic concerns, or Japanese, with their commercial reluctance. Furthermore, dealing with Europe helps China maintain its independence. These factors may explain why China seems relatively unconcerned with European protectionism and trade surpluses, even though these problems are much more severe than China's problems with the United States.

APPROACHES TO TECHNOLOGY TRANSFER

Western summit countries have taken different policy approaches to technology transfer, and the China market is no exception. Private firms are the major developers and transferrers of technology, but in some fields such as telecommunications, state-owned firms play major roles. All of the Western governments influence the nature and scope of technology transfer, albeit in different ways.[9]

Japan

Scope and Type of Technology Transfer to China

There is a sharp contrast between China's criticisms of Japan for not transferring much technology and views often expressed by U.S. businessmen that Japanese firms are actually transferring advanced technologies (sometimes exceeding or circumventing multilateral export controls). While data are not available for a detailed comparison of technology transfer from various sources, distinctive features of Japanese technology transfer to China are nevertheless apparent.

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[9] For an analysis of differing policy approaches to technology transfer in general, see OTA, *Technology Transfer to the Middle East*, September 1984, ch. 12 "Policies of Other Supplier Countries."

To set the context for the discussion of technology transfer, it should be noted that Japan has been China's number-one trading partner for more than a decade. Two-way trade reached almost $19 billion in 1985 (more than double U.S.-China trade), with Japanese exports to China valued at $12.5 billion dollars. In 1986 China was the fourth largest importer of Japanese products and the fifth largest exporter to Japan.[10] Traditionally, Sino-Japanese trade comprised an exchange of "machines for oil."[11] At least in terms of Japanese exports, this pattern still prevails: machinery exports made up 57 percent of total Japanese exports to China during 1985. Exports tripled in 1985 in automobiles, motorcycles, televisions, and other consumer appliances. In the first half of 1986, however, Japan's exports to China fell 23 percent from the 1985 level. Exports of automobiles and appliances plummeted after Chinese resentment grew over a growing trade deficit with Japan. Japan's share of telecommunications exports dropped markedly from 77 percent in 1985 to 58 percent in the first half of 1986.

Table 9 outlines the composition of Japanese exports to China. In 1986, exports of steel products constituted more than a quarter of this trade (3 billion dollars' worth). Another major export category is transportation equipment; Japan exported 936 million dollars' to China, down 58% from the 1985 level. After a surge in imports of Japanese automobiles in early 1985, and scandals involving illegal sales and defective parts, the Chinese Government imposed restrictions on imports later in the year. A third major category of exports is industrial machinery and electrical equipment. Television exports (including components) were valued at $1 billion in 1985, but dropped sharply in 1986. Chemical and textile exports were also significiant. With the completion of the Baoshan steel mill project in 1985, Japan's exports of large plants dropped. Table 10 compares U.S. and Japanese exports in key sectors.

Table 9.—Composition of Japanese Exports to China 1986 (millions of U.S. dollars)

	Value	Export share (percent of total Japanese exports to China)
Chemical goods	815	8.3%
Metals and articles thereof	3,163	32.1
(Iron and steel sheets and plates)	(1,013)	(10.3)
Machinery and mechanical apparatus	4,979	50.5
(TV receivers)	(152)	(1.5)
(Motor vehicles)	(612)	(6.2)
(Scientific, optical, and precision apparatus)	(506)	(5.1)
Textiles and textile articles	(447)	(4.5)
Total	9,856	

NOTE: General contrasts with U.S. exports, which amounted to $3.8 billion in 1985, are apparent. While U.S. agricultural exports declined, they made up a comparatively large share for the United States. Table 5-2 provides a comparison of selected equipment exports.

SOURCE: Ministry of Finance, Japan.

Official statistics cover direct trade between Japan and China and thus do not show that in recent years Hong Kong has become increasingly important as an alternative channel. Chinese officials express concern about this route, fearing reduced control over imports and prices. One observer estimated that trade through Hong Kong represents 10-15 percent of the value of total official bilateral Sino-Japanese trade.[12]

Product exports do not, of course, constitute technology transfer, but such exports often include training programs and provision of technical services. The sheer volume of Japan's machinery and equipment exports suggests that Japanese firms have played a significant role in helping modernize China's industries. In June of 1986 a high-level Chinese official noted that during the past five years 651 Japanese experts had visited China to diagnose 131 factories, and that 400 Chinese had visited factories in Japan.[13] Trade data alone, therefore,

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[10] "Japan-China Trade in 1986," *China Newsletter*, No. 67, March-April, 1987, p. 20. Two way trade totaled $15.5 billion in 1986.

[11] See Richard K. Nanto and Hong Nack Kim, "Sino-Japanese Economic Relations," Congressional Research Service, Prepared for the Joint Economic Commitee, November 1984.

[12] See Charles Smith, "The Ties that Bind," *Far Eastern Economic Review*, Apr. 24, 1986, p. 80.

[13] These numbers include both Japanese government and corporate programs. See *China Newsletter*, no. 64, Sept.-Oct. 1986, p. 10.

Table 10.—Comparison of Selected U.S. and Japanese Exports 1985 (million U.S. dollars)

	United States	Japan
Telecommunications and sound recording equipment	43.5	1,383[a]
Office machinery and equipment, including computers	187.6	122.7
Professional and scientific control instruments	279	683[b]

[a] Of which: TV receivers — $1,073.

[b] Scientific, optical, and precision apparatus, in Japan's tariff classification.

SOURCES: U.S. Commerce Dept. data, reported in *China Business and Trade*, Feb. 21, 1986; Japan Tariff Association data reported in *JEI Report* No. 14B.

Photo credit: Xinhua News Agency

The Fujian Hitachi Television Co. Ltd. in Fuzhou, a China-Japan joint venture. Photo shows a view of the assembly workshop for color and black-and-white TV sets.

provide an inadequate gauge of technology transfers.

Another approach to determining if technology transfer is occurring is to examine published contract awards. According to one such study of transfers of production technology, Japanese firms were involved in 42 of 183 transactions in 1984, while U.S. firms were involved in 71. Brief descriptions of the contracts indicate that Japanese firms were transferring some advanced technologies (in areas such as electronic control systems, production of spectrophotometers, and electrostatic copiers).[14] Chinese data indicate that whereas Japan was the leading foreign supplier of equipment (hardware), it lagged behind the United States and West Germany in "technology transactions" between 1973 and 1984.[15]

A study of Japanese plant exports to China during the period January 1984 to March 1985 identified a total of 172 cases.[16] The largest number (57) involved machinery production facilities. Chemical and food production plant exports ranked second and third. A close examination of the electric machinery plant exports indicates that most involved consumer product manufacturing technology (TVs, refrigerators, and washing machines). The total value of these plant exports was $640 million, indicating the small scale of many of the projects.[17]

During the same period, an additional 182 cases of technology transfer unrelated to large plant exports occurred.[18] The number of these contracts rose rapidly in late 1984 and early 1985, a large proportion involving parts supply for knockdown production in China.

About 75 percent of the cases involved technology transfers to machinery-producing firms in China. Fifty cases involved electrical machinery-producing firms primarily involved in consumer goods production.[19] While only 16 cases involved industrial goods production, these included calibration and instrumentation technology needed for "industrial renovation" projects in China. Table 11 provides a summary of technology transfers from Japan to China in the 1984-85 period.

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[14] Donald R. DeGlopper, "China's Import of Foreign Technology, Survey and Chronology," DDE-1924-2-85, report for the Defense Intelligence Agency, August 1985.

[15] See Li Hao, "In Search for a Perfect Balance," *Intertrade*, September 1985, p. 13. By value of transactions, Japan was on a par with West Germany as a supplier, but it lagged in numbers of transactions.

[16] These cases all involved exports of manufacturing equipment and technology (rather than simple exports of machinery and equipment).

[17] More than 35 percent of the projects were valued at less than $1 million. Data from Japan Machinery Exporting Association, *Tokutei Shijo no Shoraisei Bunseki Chosa Hokoku*, July 1985, p. 160.

[18] In this study, technology transfer is defined as contracts involving any of the following: licensing, software and management, consulting, or parts supply.

[19] About 68 percent of the cases in this category (electrical machinery producing firms) involved technology for production of TVs, washing machines, and refrigerators.

Table 11.—Technology Transfer From Japan to China, 1984-85

	Number of Cases	Percent of total
Mining	2	1
Construction	2	1
Manufacturing	169	93
Electrical machinery	50	29.6
Industrial	13	
Consumer	47[a]	
General machinery	38	22.5
Transportation machinery	25	14.8
Textile machinery	25	14.8
Transportation and communications	1	5
Wholesale, retail	1	5
Services	7	4
Total	182	

[a] Includes primarily TV, washing machine, refrigerator, and other consumer product manufacturing technologies.

SOURCE: Japan Machinery Exporting Association, Tokutei Shijo no Shoraisei Bunseki Chosa Hokoku, July 1985, p. 182.

Joint venture projects involving Japanese and Chinese firms provide another vehicle for technology transfer. China's leaders have indicated their dissatisfaction with the level of foreign investment and have taken a number of steps to attract additional investment. Japan, in particular, has come under criticism.[20] In view of the large volume of Japanese exports, the argument goes, Japanese firms should be more involved on the ground in investment projects likely to involve technology transfer.

China's data on foreign investment cover a number of categories, including cooperative ventures, joint development projects (particularly in offshore oil development, compensation trade, processing arrangements), and equity joint ventures.[21] The Japan External Trade Organization (JETRO) data collected by the Ministry of Foreign Economic Relations and Trade indicate that by late 1984 Japanese firms were involved in 26 of 429 equity joint ventures that Chinese firms established with foreign firms. Japanese investments were limited and focused primarily on offshore development projects. An additional 80 investments were reported in 1985, but investments from other countries also grew rapidly. As a result, Japanese investors were involved in only about 3.4 percent of the total number (2,300) of foreign investments reported by China.[22]

A good share of the investment projects outside the oil development field were in service areas such as hotel and restaurant ventures and leasing operations. Joint manufacturing ventures involved primarily production of consumer goods. During 1985 the number of cooperative projects increased, and JETRO's listing indicates that a greater number involved higher technology and manufacturing operations. Nippon Steel, for example, signed a contract worth $100 million with a Chinese partner to set up an engineering company. In another case, a Japanese firm contracted with the Chinese Academy of Sciences to establish a joint software development firm.[23] In 1986 Furukawa Electric agreed to a joint venture in Xian for producing optical fibers and cables.

Japan's experience in China is thus extensive, yet technology transfer has been concentrated in certain areas, especially technical consulting and training associated with plant exports. A firm like JGC, for example, has had more than 21 large contracts in China involving oil, petrochemical, and gas production projects. In these projects technology transfer has occurred, often involving firms from other supplier countries, in the sale of patents and the provision of know-how.

Perhaps the prime example is Baoshan, the large steel works completed outside Shanghai in 1985. For Nippon Steel, the major Japanese company involved in this state-of-the-art steel complex, the project offered a chance to train young Japanese engineers in a government-supported effort during a period of intense global competition in the industry. Although the project has suffered many problems, including a scaleback in the early 1980s, it involves significant technology transfer from Japan to China. More than 1,200 Chinese have been trained in Japan and hundreds of Japanese have been sent to China.[24]

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[20] See, for example, "Foreign Investment Placings Fail to Satisfy Chinese," *Financial Times* (London), Jan. 30, 1986, p. 6.

[21] See Nai-Ruenn Chen, *Foreign Investment in China: Current Trends*, U.S. Dept. of Commerce: March 1986, for a discussion of China's investment data. Statistics recorded here indicate that Japan was a close third (following Hong Kong and the United States) in cumulative pledged equity joint investment by the end of 1984. See p. 11.

[22] See Charles Smith, "The Ties that Bind," *Far Eastern Economic Review* Apr. 24, 1986, p. 74.

[23] See, for examples, Japan External Trade Organization (JETRO), *China Newsletter*, No. 58, p. 21.

Firms like the Nippon Electric Co. (NEC) have developed carefully honed technology transfer strategies. NEC has joined with a Chinese partner to produce 16-bit microcomputers. It is also a partner in the Japan-China Software Center. Interestingly, NEC training of 1,000 Chinese software engineers has been a boon to NEC, which faces a shortage of trained personnel.[25] NEC's strategy involves technology transfer to China in certain areas that complement NEC's own needs and marketing plans.

To summarize, technology transfer from Japan has occurred to a great extent in exports of standardized production facilities for manufacturing consumer goods, and in training and technical consultation for large infrastructure projects.[26] Specialized technical exchanges between Japanese and Chinese organizations are also a vehicle. The Industrial Bank of Japan (IBJ) for example, runs seminars on financial services for Chinese trainees. There is a constant movement of specialized personnel between organizations such as the IBJ and the Bank of China.

Technology transfer is fundamentally a people-to-people process, and the establishment of hundreds of branches of Japanese firms in China testifies to the importance of Japan's role. In 1984 more than 41,000 Japanese visited China, or more than 100 daily.[27] (Many of these individuals were undoubtedly primarily involved in exports of products and services). China's factory renovation program involves many Japanese consultants and advisors. On the other hand, the Japanese Government has funded only 300 scholarships for Chinese students although officials have expressed their commitment to increase this number to 500 by 1989.

There is some truth as well as some misperception associated with the commonly held view in China and Japan that not much technology transfer has occurred. The general pattern has been one of product and, to a less extent, service exports, with transfers of technology occurring primarily in standardized consumer product manufacturing or in the context of large projects. Such technology transfers may attract less interest than licensing state-of-the-art technology, but they can be a critical factor in industrial renovation projects.

Organizations and Participants: Technology Transfer Japanese Style

Japan's foreign economic policymaking system is more centralized than that of the United States, but there is a range of perspectives on technology transfer to China. The official Government position, reflected in programs supporting extensive Japanese participation in China's modernization, contrasts with a more cautious approach by private sector firms to technology transfer and investment.

Differences between government and business on technology transfer are, of course, well publicized, and more the norm than the exception in the United States. In Japan a number of institutional mechanisms build consensus between public and private leaders active in technology transfer. While Japanese leaders question the notion that Japan has a national strategy on technology transfer, the generally complementary efforts of public and private officials are certainly assisted by these avenues for information exchange and consensus building.

At a government level, Japanese leaders are committed to building economic ties with China. Yet there is a range of views on specific issues that reflect differing insitutional missions. The Ministry of Foreign Affairs

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[24] Ikuo Hirata, "Baoshan Steel Works," *Journal of Japanese Trade and Industry*, No. 5, 1985, p. 17.

[25] Interview with Yukio Mizuno, Senior Vice President, NEC, November 1985.

[26] Other Japanese firms like Toyota, which are major exporters of vehicles to China and have extensive service operations there, have foregone equity joint ventures. Many Japanese firms appear wary of China's employment and other requirements on foreign firms.

[27] Kazuhiko Mitsumori, in *Gendai*, October 1985.

(MOFA), the lead agency in formulating foreign policy, has traditionally been careful to ensure that policies toward China mesh with Japanese policies toward other Asian countries.[28] MOFA's current policy toward China, based on three principles mentioned earlier, was developed in the late 1970s, in part to clarify debates over whether the Japanese Government should offer official loans and official development assistance to China. In these debates, the Export-Import Bank, the Ministry of Finance, the Ministry of International Trade and Industry (MITI), as well as Liberal Democratic Party (LDP) politicians played key roles.

MITI, the traditional leader of Japan's postwar trade and industry policies, has developed a view that Japan's comparative advantage lies in knowledge-intensive industries and a more internationalist approach. MITI's view is that Japan must promote the international transfer of technology through overseas investments and other means to maintain its competitive position and mitigate trade frictions with other countries.[29]

Debates among key ministries over levels of official development assistance for China have had more to do with the scope and mechanisms for participation in China's modernization than with the fundamental rationale. Whereas U.S. concerns over national security are embodied in export controls, Japan sees expanded economic interaction as the primary avenue for attaining strategic goals vis-a-vis China.

Despite this formal consensus on overall policy directions, Japanese leaders contend that there is no clearcut national strategy on technology transfer. Acknowledging their concern over China's criticisms of Japan for not transferring more technology, Japanese leaders promise to expand technical cooperation programs and financing of large projects. At the same time, government leaders indicate that China may be pressing too hard for the most advanced technologies.[30] Japanese policy makers prefer a step-by-step approach because they believe that during this transition period in China a proper foundation must be built.

Japanese businessmen, in particular, appear cautious about technology transfer to China. They emphasize obstacles to technology transfer such as inadequate infrastructure, bureaucratic sectionalism, limitations on management discretion in hiring and operating enterprises, and China's tendency to undervalue software and training. These concerns explain in part the willingness of Japanese business to sell goods to China while avoiding extensive investments. Acutely aware of the special expectations China has concerning Japan's contribution, they stress differences in Chinese and Japanese negotiating styles and other factors that set constraints on the ability of Japanese businessmen to fulfill expectations.

Distinguishing Japanese approaches to technology transfer are key organizations that bridge the distance between government and business, expanding economic ties to China. One such organization is the Japan China Association for Economy and Trade (JCAET), formed in 1972. JCAET is a hybrid organization that includes many retired government officials (most of them from MITI), businessmen, and China experts from organizations such as the Institute for Developing Economies. JCAET provides a wide range of services to Japanese firms interested in China trade, such as detailed surveys of conditions in China, while facilitating exchanges with Chinese leaders. The boundaries between MITI, JCAET, JETRO, and other key institutions are fluid in the sense that individuals are often detailed from one organization to another to help with specific projects. JCAET is thus part of a network of organizations that work closely together to increase Japan's knowledge of and exchange with China's economy. The perspectives of individuals and organizations vary, but the network ensures that information is shared and that major participants are cognizant of key problems and issues. The effectiveness and utility of information gathered through an extensive network in China is reflected in statements by Chinese leaders that Japanese understand well the intricacies of China's contract approval process.[31]

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[28] Up until 1972, the Foreign Ministry was more reluctant than the Ministry of International Trade and Industry (MITI) to open relations with the People's Republic of China (PRC) and more intent upon preserving diplomatic relations with Taiwan. See Chae-Jin Lee, *China and Japan* (Hoover Press, 1984), p. 12.

[29] The report was prepared by the Planning Subcommittee of the Industrial Structure Deliberative Council to MITI in preparation for the Tokyo summit in May 1986. See *Mainichi Shimbun*, Feb. 1, 1986, p. 1.

[30] Official programs carried out by the Japan International Cooperation Agency in the factory renovation area are explicitly designed to promote transfers of standardized (rather than new) technologies.

The low-profile, consensus-building approach carries over to bilateral exchanges as well. Japan and China have established the Twenty-first Century Committee, composed of 11 members from each country who exchange views on issues of bilateral importance. On the Japanese side the committee is staffed by MOFA, but the discussions are considered unofficial. High-ranking leaders in the China field from business and academe and former government officials make up the Japanese delegation. The committee is a mechanism for frank but high-level and closed-door communications between the two countries. Reportedly, the group has discussed sensitive issues such as Chinese anti-Japanese demonstrations and trade frictions. Interestingly, a major focus of attention has been youth exchange. At the committee's instigation, a youth center is now under construction in Beijing, and a number of exchange programs for young people have been sponsored. The committee is thus more than an advisory group; it can marshall the resources needed to implement projects.

Organizational and personal ties between Japanese business and government leaders with their Chinese counterparts are old and extensive. Yet, uncertainty about Japan's role in technology transfer remains. For both sides, the impacts of this critical period of experimentation with new modes of bilateral interaction will extend beyond the bilateral relationship.

Whether or not Japan will transfer enough technology to meet China's expectations remains an open question. On one hand, Japanese firms may continue to chart a cautious approach to investment, waiting to see how China will implement its policies and gradually building expertise and confidence in their technology transfer capabilities. On the other hand, expanded trade in more sophisticated products and services appears likely now that regulations of the Coordinating Committee for Multilateral Export Controls (COCOM) have been loosened.[32] Even if direct equity investments remain comparatively limited, technology transfer from Japan associated with such sales will expand. If a few key Japanese firms demonstrate success in joint ventures involving advanced technology transfer, moreover, others will surely follow. Thus, while Japanese firms and organizations may continue to use different modes and mechanisms for technology transfer, they will likely continue to be the most significant competitors for the China market.

Europe

Technology transfer from Europe to China takes all the forms seen in the transfers from the United States or Japan. Technology is embodied in equipment, sold in conjunction with equipment, sold independently as in licensing arrangements, included in investments such as joint ventures, and transferred by governments and institutions directly to China or in the form of education received by students attending European universities.

Two-way trade between the European Community and China was almost $7 billion in 1985. Trade increased about 25 percent from 1984, thereby surpassing the U.S.-China level. Table 12 shows the shares of the individual countries.

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[31] For a detailed chart of the contract approval process for Japanese-Chinese joint ventures, see Masao Sakurai, *Kokusai Kyoryoku no Wakugumi to Ho* [The Framework and Law for International Cooperation] (Tokyo: Sanshodo, 1985), pp. 202-3.

[32] Hitachi won a contract to export large-scale computers to the Bank of China soon after the loosening of COCOM rules. See "Hitachi to Export Computers to China," *Asahi Evening News*, Feb. 14, 1986.

Table 12.—European Trade with China in 1986 (billion U.S. dollars)

	Total	Percent over 1985	Exports	Imports	Export/total
Germany	$4.07	31.2	$2.87	$1.20	70%
Britain	1.41	42.4	0.78	0.62	55
France	1.25	-2.4	0.67	0.58	54
Italy	1.68	21.2	1.00	0.68	59

SOURCE: IMF Direction of Trade Statistics as reported in *China Business Review*, vol. 14, No. 3, May/June 1987.

The Federal Republic of Germany

Germany has the largest share of the European trade and the greatest financial involvement in China. China was Germany's largest trade partner in the developing world in 1985, though China's deficit in this trade may limit future growth.[33] China has established its European Trade Center in Hamburg to facilitate China's exports to Europe.

Technology transfer has been an important part of this relationship. For instance, Schloemann-Siemans A.G. successfully competed with Japanese companies for a $626 million contract to supply a hot-strip mill at the Baoshan steel plant, largely by offering advanced technology with considerable technology transfer. The company has brought many Chinese designers to Bonn for training in modern management techniques. Germany has been particularly strong in transferring production technology such as machine tools and chemical processing plants.

In a study of technologically oriented exports to China in 1984, Germany ranked third, behind the United States and Japan, with 17 of the total of 182 exports.[34] In 1985 the value of technology exports from Germany may have exceeded those of both the United States and Japan, even though the number of contracts did not.[35] Machinery and production technologies or transportation equipment were the largest components. Electronics have also been important. In 1985 a complete semiconductor production plant was exported, as were facilities for the production of floppy disks and telecommunications equipment.

Twelve joint ventures were established by the end of 1985.[36] None of them involves production of high-technology equipment. Most have been with mid-size German companies in areas such as food processing. One joint venture that doesn't involve much technology but may expedite European trade with China is a shipping company that will use the Trans-Siberian Railroad to avoid the long delays in Chinese harbors.

The largest joint venture is the Shanghai Volkswagen Automobile Co. Ltd. (SVW), which started production of the Santana automobile in 1985. SVW is assembling kits imported from Germany at the rate of 800 cars a month.[37] Only a few parts come from China, but it is hoped that eventually all will.[38]

Many problems have been experienced. The production line for the Santana was added to a factory that had been producing small numbers of a car that had remained essentially unchanged in design for 27 years. The management team and the workforce had to be largely retrained, and the German management found that some of its methods were not applicable to China. Distribution and service of the cars in China have been unexpectedly difficult. China has also had difficulty raising its share of the capitalization, in part because of the plummeting value of the yuan. Estimates of future capital requirements for building the facilities for the local production of parts and supplies have risen sharply, evidently causing some ill will between SVW and Beijing. The shortage of foreign exchange has also hampered China's ability to pay for the kits, a situation similar to that faced by the Beijing Jeep Corporation in its arrangement with American Motors.

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[33] Foreign Broadcast Information Service, Daily China Report, May 13, 1986.

[34] DeGlopper, op. cit.

[35] Liu Hu, "Technology Import Reaches New High," *Beijing Review*, No. 10, Mar. 10, 1986.

[36] Foreign Broadcast Information Service, China Daily Report, Sept. 4, 1986.

[37] Yue Haltao, "How Volkswagen Performs in China," *Beijing Review*, No. 29, July 21, 1986.

[38] H.L. Stevenson, "Chinese and Germans Team Up To Build VWs," Automotive News, Oct. 21, 1985.

Licenses to manufacture have been more important means for technology transfer than joint ventures. For instance, Motoren Werke Mannheim AG has granted a license for the production of diesel engines for agricultural and construction uses, an area where China could derive considerable economic benefit. A more complicated agreement was signed by Dr. Eng. Rudolf Hell Ltd. for the manufacture of color separation scanning chromographs. China will first assemble kits from Germany, but within 5 years the manufacture should be all domestic. The agreement includes training of Chinese engineers in Germany. Siemans AG has granted many licenses, which include training in Germany and startup assistance at the Chinese plant.

The purchase of used equipment has become a significant means for increasing production capacity, though it obviously involves older technology. China has purchased at least two German factories, for motorcycles and bicycles, and a spinning mill and reassembled them in China. These ventures have provided China with manufacturing facilities considerably more modern than the norm in China, at a small fraction of the cost of new equipment.

In another form of technology transfer, the Chinese-West German Technical Training Center has been established in Tianjin with a grant of DM35 million. The center provides training in machinery, computers, electronics, and instrumentation to about 400 trainees.

Germany's program to send retired managers to China to provide advice and assistance resulted in an unusually personal form of technology transfer when one of the volunteers, Werner Gerich, was appointed the manager of the Wuhan Diesel Engine Factory. The factory was having major problems with production, especially in the quality of the engines. Gerich instituted a series of reforms that have significantly improved quality, volume, and profits. With the backing of local officials and the Party, he implemented an incentive wage system, streamlined the workforce, restructured the management, and improved discipline. Many problems still remain at the plant, but Gerich is instituting a change in thinking that may be a lasting legacy.

Over 1,000 Chinese students are in German universities, and the number is growing. Compared with the 17,000 in the United States, this number seems low. Perhaps the relatively few overseas Chinese in Germany and the dearth of German-speaking Chinese are factors.

Germany has much to offer China. Its technology for production is justly famous, and that is the technology in which China is now most interested. Quality control in particular is a German strength that China can usefully learn. In some areas, such as computers, German technology has lagged behind that of the United States and Japan, but not by so much as to affect the utility of Germany's products to China. It is reasonable to conclude that unless economic factors in China interfere, this relationship will continue to grow. If Germany has been cautious in starting joint ventures or other investments in China, it is not because of particular inhibitions about China but because German industry is cautious in general and does not need new productive capacity.

The German Government's major role in technology transfer is that of facilitator more than participant. The private sector has the lead in making contacts, negotiating the terms, and fulfilling contracts. The Government has signed a large number of accords on science and technology cooperation with China, opening the way for industry. These have been arranged by the Ministry of Research and Technology (BMFT). The Economics Ministry, equivalent to the U.S. Department of Commerce, has an Office of East Asian Affairs and provides information and advice to industry, in part through the Federal Office of Foreign Trade Information (Bundestelle für Aussenhandelsinformation, or BfA). BfA, whose closest analog in the United States is the Foreign Commercial Service, analyzes economic, legal, and political information, particularly in developing countries, to assist German companies in decisions on trade and investment.

The Economics Ministry and the Foreign Office have developed a trade policy supportive though cautious of China's development. China is not seen as either an economic or political threat, whereas technological cooperation is seen as a way of encouraging China to remain open to the West and moderate in its policies. The German Government therefore encourages industry to trade with China and engage in technology transfer. Traditionally, it has not provided direct subsidies for exports, preferring to rely on market forces to reach economically sound decisions.[39] However, this policy is apparently flexible since, as noted below, at least one case of mixed credits has been announced.

The Federation of German Industries, a private-sector organization, provides services to exporters and shares in the governing of the BfA. The Joint Committee for Sino-Federal German Economic Cooperation is a body of government, academic, and industrial representatives that meet with equivalent Chinese representatives annually to discuss economic issues.

France

In general, France has been less successful than Germany in trade with China. Exports to China in 1986 totaled about $670 million, less than one-quarter that of Germany. Sino-French trade had been approximately balanced but in 1985 China's imports more than tripled, whereas exports were stable.

Major French exports include aircraft (airbuses, helicopters, and eventually, perhaps, fighters), ground transportation equipment (trains, trucks, and river shipping), and telecommunications. Technology transfer appears to be relatively more important for France than Germany. The value of French exports involving technology in 1985 was $320 million, almost 60 percent of total exports.[40] The type of technology transfer, however, differs some from Germany's, with less emphasis on setting up manufacturing facilities and more on selling specific equipment with associated technology and training. For instance, France led a European consortium that sold 300 locomotives to China. The $450 million contract included technologies of design and manufacture (as did the GE contract discussed in ch. 4); manufacturing equipment was included, but it does not appear to have been a major point of the contract.

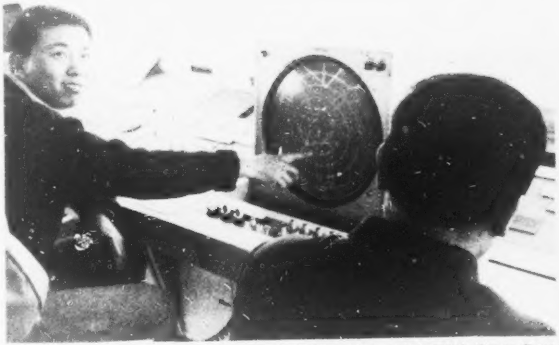

Photo credit: National Council for U.S.-China Trade

Air navigation equipment at the Beijing Airport. This equipment was supplied by France.

In another major transaction, CIT-Alcatel (a subsidiary of the state- owned Compagnie Générale d'Électricité [CGE]) sold a modern telephone switching system cabable of handling 100,000 lines. As a precondition, an electronics lab for the testing and manufacture of telecommunications equipment was included. This lab will be used for microwave, laser, and fiberoptic technologies.

China signed a contract for two French nuclear reactors late in 1986. Some opposition has arisen in Beijing (largely because of the drain on foreign exchange) and in Hong Kong, because of safety concerns. Germany's alternative bid would have permitted China to participate in the design of the plant, but China showed little interest. The United States was precluded from competing for this sale because a nuclear cooperation agreement had not yet been signed. The contract does not include extensive technology transfer, but the experience will help China to advance more rapidly with its own nuclear industry. However, China will require considerable additional assistance before it will be able to produce a world-class reactor independently.

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[39] U.S. Congress, Office of Technology Assessment, *Technology Transfer to the Middle East*, OTA-ISC-173 (Washington, DC: U.S. Government Printing Office, September 1984).

[40] Liu, op. cit.

In several negotiations, the French have noticed that China first asked for the latest technology but later realized that older technology would be more suitable. For example, the locomotive technology eventually selected uses continuous traction, a technique that was phased out in France 10 years earlier in favor of synchronous traction. The nuclear reactors were also not the latest that France has to offer. In both cases, the French were willing to transfer the more advanced technology, but the Chinese independently decided to back off.

The French pattern of establishing joint ventures has been remarkably similar to Germany's. None of France's 11 joint ventures has involved high technology. Most have been in food processing, but the largest is in the automobile industry. Peugeot created The Guanzhou Peugeot Automobile Co. to build about 15,000 light trucks (pickups) per year.

One area in which Sino-French cooperation has been very strong is science. A wide range of cooperation agreements has been signed, and many Chinese researchers spend a year or more working in French laboratories. It is likely that this scientific cooperation reinforces the readiness of China to acquire technology from France.

There are about 1,000 Chinese students in France, mostly in science and technology. The total is not growing very rapidly and is likely to remain proportionally well below that in the United States because French scholarships are mostly government sponsored and are neither as flexible nor as generous. Chinese students are frequently funded by their government for only one year; if they wish to remain, they must find their own support.

The French Government plays a much more active role in most aspects of technology transfer than do the German and U.S. Governments. Most companies involved with high technology are owned by the French Government, such as CGE. While the effect on corporate efficiency and vigor might be questioned, this factor ensures close cooperation between industry and government. Government officials often see themselves as representatives of French business in a way that China is likely to find familiar and comfortable. Although French policy may be changing (the Government has already announced that it intends to divest itself of CGE and other major companies), this arrangement has worked well, at least for initiating technology transfer arrangements. For instance, the nuclear vendor Framatome is Government owned, and the Government made strenuous efforts to win the Daya Bay contract, including direct negotiations and concessionary financing. The French National Railroad will have a permanent representative in Beijing, presumably to encourage transactions such as the contract for the locomotives. However, the overall number of French officials in China is not very high, and theoretically the burden of concluding agreements is on the companies.

United Kingdom

Britain is China's second largest trading partner in Europe and a major supplier of technology. The largest single transaction (250 million pounds) has been the sale of the turbine-generators for the Daya Bay nuclear power plant, in conjunction with the two reactors supplied by France, though little technology transfer was involved. Other major exports include scientific instruments, synthetic fibers, steel products, telecommunications, and coal mining equipment. As with other European countries, China's trade balance with Britain is in significant deficit.

Britain is unique among the industrialized trading partners of China in its control of Hong Kong. Hong Kong's trade with both Britain and China greatly exceeds trade between Britain and China, but this does not appear to be a major conduit for British goods relative to other countries. Furthermore, any special relationship that Hong Kong provides is likely to dissipate over the next decade, when Hong Kong reverts to China.

Appendix 6 in Volume II to this report lists six dual-use technology transfers from Britain (1984-85), compared with three from Germany and four from France, suggesting that Britain has a relative advantage in high-technology exports. The pattern of Britain's technology transfers to China resembles France's more than Germany's. Licensing, training, and sales of specific equipment and information have been more important than production lines, though several of the latter have been supplied. British Rail Engineering has a contract for 5 million pounds to sell three advanced rail coaches and the design technology to the Changchun Railway Passenger Works. Assistance will also be provided in modernizing the plant.[41]

Racal Electronics has had several major contracts involving equipment, technology, and coproduction arrangements. It has sold radar for ship and air traffic control and transferred the technology to produce radar equipment. The technology transfer appears to have been a key element in gaining contracts for Racal.[42]

The production lines that Britian has sold include plastic sheeting and audio and video tape. However, Britain appears to have played a bigger role in helping get other projects completed after they run into trouble.

There have been only about 12 joint ventures, but they have been the result of some of the largest contracts. Lingnam Microelectronics Investment Co. (a consortium of British companies) is building a $50 million facility to produce large-scale integrated circuits and microcomputers. Pilkington Brothers is constructing a plant near Shanghai in partnership with two Chinese companies to produce high-quality glass using modern technology. The plant will cost $120 million and will be the largest producer of glass in China when it comes on line in 1987.[43] This project, as with many other large joint ventures, has had foreign exchange and managerial difficulties.[44] Other joint ventures include heavy truck assembly by Aveling Burford and automobile batteries by the Chloride Group and Singer.

Coproduction is likely to be more acceptable than joint ventures to British companies. Racal Electronics has noted that coproduction offers almost the same benefits to China and avoids many of the problems.[45]

Much of the technology transferred has been fairly basic: pumps to drain coal mines, reinforced concrete pipes, wire-rod mill equipment, technology for foundries, and extrusion equipment for aluminum products. Some have been quite advanced: microelectronics, fiberoptics, telecommunications, and radar.

British companies appear more concerned than French or German companies about future competitiveness, at least for traditional technology industries. As in other countries, many companies have been disappointed following their expectation of the 1970s, especially considering the number of Chinese visitors they have received. Of the 185 Chinese delegations in 1985 who looked at British products and technologies, very few have followed up their visits, and fewer still have produced any business.

One area in which Britain has excelled has been in education and training. Britain has over 1,200 Chinese students, more than in Japan, Germany, or France, and the number is rising rapidly. As with the United States, the popularity of the English language, the reputation of the universities, and the availability of scholarships are major attractions for the Chinese. Moreover, British industry is training over 1,000 Chinese, mostly in technological areas. Training is a standard feature of China trade and investment and will probably increase in the future.[46]

The British Government is more of a facilitator than a participant, as is the case in Germany. Most technology transfer is accomplished by the private sector through commercial contracts. The Government provides information and some financing, part of which is subsidized, and helps create an environment conducive to doing business.

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[41] China Business & Trade, May 23, 1986.

[42] Nigel Campbell, *China Strategies—The Inside Story*, University of Manchester/University of Hong Kong, 1986.

[43] Kelly Ho Shea, "Modernizing Flat Glass Production" *The China Business Review*, Volume 13, Number 3, May-June 1986.

[44] Nigel Campbell, op. cit.

[45] Ibid.

[46] Sino-British Trade Review, January 1986.

High-level British officials visit China regularly to make contacts, present British capabilities, and negotiate bilateral agreements. Queen Elizabeth toured China in October 1986 while a Sino-British trade and economic cooperation seminar met on the royal yacht. The seminar resulted in the signing of 13 agreements, memoranda, and letters of intent on cooperative projects, including a joint venture on a large steel plant and a major telecommunications project.[47]

The Department of Trade and Industry (DTI) is the major British Government organization involved in export promotion. The regional branch is under the direction of the Assistant Secretary for China, Hong Kong, and Macao. Trade with Hong Kong is about three times that with China, but China probably gets more attention, in part because the trade is growing rapidly and the potential is so great.

The British Overseas Trade Board, a division of DTI composed of government and industry officials, provides market research and intelligence. Much of the information on China comes from the Sino-British Trade Council (SBTC), a semiprivate advisory group (one of 15 such groups) that plays a role somewhat akin to that of the National Council for U.S.-China Trade. The SBTC is associated with The 48 Group of British Traders with China, which maintains offices in both London and Beijing and provides consulting services and contacts for trade in both directions.

These efforts have produced results, but perhaps much less than had been expected. Britain has several important advantages—the Hong Kong link, the English language, an excellent research and development system, and the distinction of being the first Western country to recognize the People's Republic of China Government—but these have not given Britain a notable head start. Germany has done much better, and Italy moved ahead in 1986.

Several factors suggest themselves to explain this indifferent record, and some of them may have relevance to the United States, also. Britain has not been strong at production, and Germany's success is at least partially due to its excellence in production machinery, which is at the top of China's list of needs. The United States has also lagged in the production of equipment such as machine tools and has not competed well in China. British Government-subsidized financing became significant only recently, as described below, while Italy's exports to China have benefitted from aggressive government financing. Germany's success despite a reluctance to subsidize financing shows that is not a requirement, but it helps. British industries also seem to be unaggressive and less innovative compared with those from other countries. A few are major world players, but Britain is more of a financial center than an industrial one.

EXPORT CONTROLS

The major countries supplying advanced technology to China today are all members of COCOM, the voluntary multilateral organization set up to coordinate controls on exports to the Soviet bloc. The goal of joint export-control efforts is to prevent access by the Soviet bloc to weapons and advanced technologies with military significance. COCOM members have developed, however, quite different perspectives on and approaches to trade with the Soviet bloc, leading at times to controversies among them.[48]

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[47] FBIS, China Daily Report, Oct. 16, 1986.

[48] See OTA, *Technology and East-West Trade* (September 1979); OTA, *Western Technology and Soviet Energy Availability* (November 1981); OTA *Technology and East-West Trade: An Update* (May 1983).

Regulations on exports to China were significantly relaxed by COCOM in late 1985, as discussed more fully in chapter 8. COCOM member countries were authorized to approve certain exports to China of equipment and technology with notification to COCOM.[49] COCOM review is still required for more sophisticated dual-use technology, for military exports, and for nuclear exports. These changes appear to have been well received by COCOM members and by China. Earlier concerns about "differentiating" China in COCOM policy from Soviet bloc nations have apparently proven to be no obstacle.

Nevertheless, for several reasons, industry in particular remains uncertain about the rationale for multilateral export controls, the functioning of the COCOM system, and the implementation of domestic export administration systems by COCOM countries. Company representatives have at times contended that other participants (firms and governments) are not following the same game rules.

Because the technical underpinnings of the COCOM list are not made public for reasons of national security, and because COCOM procedures and discussions are treated as confidential, there is room for misunderstanding. Furthermore, perceptions tend to lag behind the realities of change in export controls. Businessmen on visits to China see advanced technologies supplied by firms from other countries as signs of COCOM rule-breaking, but such charges are often mistaken. It should be emphasized that these complaints are in no way unique to U.S. exporters; European and Japanese businessmen also question whether the United States uses COCOM to its own advantage.[50] Competition for sales in the Chinese market thus raises collective problems for Western suppliers.

Several situations could lead to misunderstandings about export controls. The clearest case, from a Western alliance perspective, would be if a COCOM member government willfully circumvented the COCOM rules or "looked the other way" while domestic firms sold to dummy companies that were conduits for illegal trade. But while charges of "cheating" are often heard, OTA has not been able to document such cases.

Another complaint centers on differences in the approaches to export controls taken by various supplier countries. Because the major supplier countries devote different resources to export control, process licenses at different rates, and have different legal bases and diverging traditions of government-business relations, uncertainty abounds concerning the actual workings of the systems of the other countries.

Still another problem stems from different interpretations of the technicalities of export-control specifications for particular products. The concept of "national discretion" is built into the system. Some governments appear to be more willing than others—the United States, in particular—to make more liberal interpretations that are helpful to national firms. Since early 1984, U.S. semiconductor equipment manufacturing firms have complained that U.S. export regulations prohibit them from exporting single-wafer plasma etching systems to China, although other COCOM countries have approved such exports. They have similarly complained that the United States denied exhibition licenses for digital optical transmitters and receivers to U.S. firms, while Japanese firms were able to show similar products at a Shanghai trade show in 1986.[51] Differences in interpretation of regulations may relate to the fact that some COCOM countries have published the changes in COCOM policy concerning exports to China; other countries have not.

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[49] COCOM member countries now also approve re-exports to China of such equipment and technologies. In such cases, notification to COCOM is made.

[50] This type of complaint occurred, for example, when the United States instituted a liberalized export policy for China in 1983. At that time, certain types of exports (in the "green zone") were identified as likely to be approved. For those exports (including "green zone" exports) requiring COCOM review, the United States continued to submit cases to COCOM for approval. Others suppliers charged, however, that U.S. export controls for China were loosened prior to COCOM policy changes, giving U.S. firms some advantage.

[51] American Electronics Association, Case Study Report: American Electronics Association Export Control Task Force, Mar. 12, 1987, pp. 18-19.

To the frustrated businessman, all of these problems stem from differing approaches to export controls. Only the first case constitutes a clear breach of joint understanding among COCOM governments, which would be legitimate cause for multilateral concern. However, other types of differences also cause resentment and misunderstanding even though they are primarily domestic issues. From a public policy perspective, however, it is critical to distinguish these differences in approaches to export controls. Recent changes in COCOM policy on exports to China appear to have brought the policies of these countries closer together, but significant differences in approaches remain. Improved understanding of export-control systems of other COCOM countries could help clarify the complaints that exporters sometimes make about U.S. policymaking.

Japan

The basis of Japan's export control system is the Foreign Exchange and Foreign Trade Control Law. Japanese export controls cover dual-use technologies, ordnance, and atomic materials. The exporter is required to obtain permission from MITI when exporting these items, particularly to Communist bloc countries. MITI has made public a list of strategic goods covered by export controls and an outline of the approval system for exports to various countries.[52] A Cabinet order stipulates that MITI permission be required for transfers of technology deemed by MITI to present possible hindrances to the maintenance of international peace and security. According to the law, punishment for exporters (including corporations) who ship strategic goods without proper permission is imprisonment for not more than 3 years and/or a fine of not more 1 million yen (about $7,000 at an exchange rate of 145 yen to the U.S. dollar).

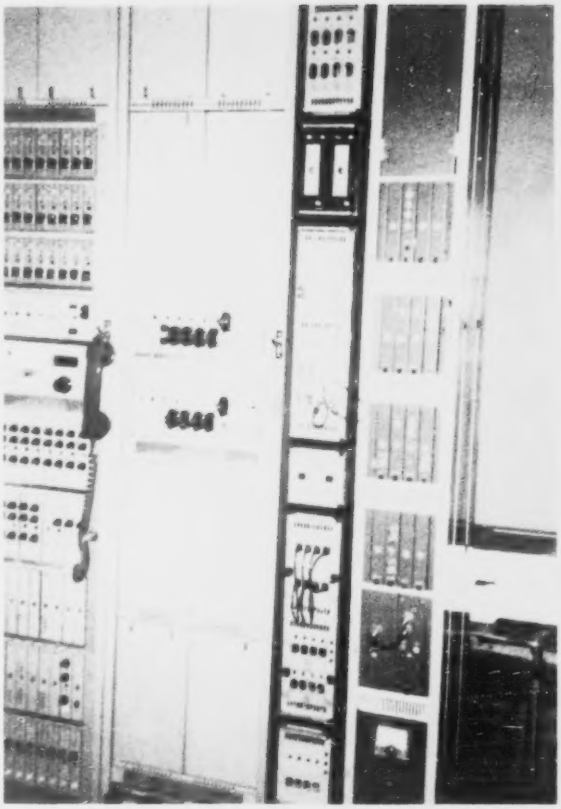

Photo credit: National Council for U.S.-China Trade

An optical fiber waveguide technical equipment bay with 120 channels in Wuhan. China has imported optical fiber technology from several countries and is rapidly gaining proficiency. U.S. companies have been refused export licenses.

Several MITI offices are involved in reviewing exports. Most exports are first reviewed by the Machinery and Information Industries Bureau, where preliminary approval is given. In practice, most firms consult with MITI routinely and informally before drawing up a formal contract. The formal review often takes place quite quickly, since preliminary discussions have already taken place and any obvious problems have been worked out. The second-stage review is handled by the Export Division of the Trade Bureau, where the legal aspects of the contract are considered and a detailed payment schedule reviewed. MITI's Security Export Control Office reviews applications for export of strategic goods and technologies to the Soviet bloc and China.

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[52] Nihon Boehi News, *Bueki Tetsuzuki Zenkai*, vol. 30, 1987, p. 163ff.

There is evidence that Japan has placed more stress on export controls in recent years, augmenting MITI capabilities in this area. In particular, Japan has identified firms illegally exporting to the Soviet Union and published their names and imposed orders to stop exports.[53] In May 1987, the government of Japan ordered Toshiba Machine Co. and C. Itoh to suspend sales to the communist bloc after it was discovered that these firms had made unauthorized sales of militarily critical machine tools to the Soviet Union.[54]

MITI has recently established guidelines to regulate Japanese exhibits at trade fairs in Communist bloc countres. Also indicative of growing commitment among Japan's leadership to restrict Soviet access to sensitive information is LDP sponsorship of a bill that imposes stiff penalties on disclosure of official secrets, despite opposition from other parties that fear the effect could be to limit freedom of speech.[55]

Soon after COCOM controls were relaxed, there were reports of new high-technology sales of semiconductor manufacturing equipment and large-scale computer systems by Japanese firms to China. The speed with which these exports were approved by the Japanese Government indicates a general predisposition to support high-technology transfers that are not clearly among the items controlled by COCOM. However, Japan is unlikely to participate in military sales.

While Japan's export approval process generally operates quite rapidly, a few cases involving exports to China have met with some delay and controversy. In one case, the export of VCR manufacturing equipment was permitted, but with modifications that protected the sensitive technologies.[56] In another case, it was reported that MITI forced changes in a training program for computer software because part of the course related to militarily useful computer graphics.[57]

The Japanese Government, if not some private Japanese companies and individuals, appears to have supported COCOM controls.[58] OTA was unable to obtain evidence of instances where the Japanese Government knowingly evaded COCOM review of items on the control lists. Because of its peace constitution, Japan has prohibited most exports of military equipment and technology.[59]

Japan's approach to re-exports and extraterritoriality is more similar to that of Western Europe than the United States. Japan takes a negative view toward extraterritorial applications of laws. The Japanese Government requires documentation when strategic goods or technologies are exported, but no attempt is made to ascertain whether retransfer has occurred.[60] In light of the large volume of trade within Asia, strategic goods and technologies could thus be diverted through third countries.

Europe

European countries have historically been more export dependent than the United States, and some governments have attempted to expand economic interactions with the Soviet bloc even during periods when political relations were cold. Economic sanctions against the Soviet Union, as proposed by the United States from time to time, have often been viewed by Europeans as naive and futile, however sympathetic they may be to the motivation. Efforts to withhold gas pipeline technology in 1981 were rejected even by the closest U.S. allies. There is, nevertheless, a general feeling by major European governments that COCOM has proved a valuable tool for thwarting the Soviet bloc's acquisition of advanced Western technology because COCOM focuses on an agreed upon list of technologies with clear security implications for all members.

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[53] See *Nihon Keizai Shimbun*, Dec. 27, 1984, for a report of an interception by Japanese customs of an export of a sonar system to the Soviet Union.

[54] See "Firms Barred from Exporting to Communist Nations," Kyodo, May 15, 1987, FBIS, *Daily Report: Asia & the Pacific*, May 19, 1987, p. C2.

[55] Such a bill was submitted to the Diet in 1985, but was abandoned after opposition parties entered into prolonged debate. In November 1986 a special LDP committee was considering whether to resubmit the bill.

[56] The *Yomiuri Shimbun* reported on Mar. 28, 1987 that MITI had issued warnings to firms involved in illegal expots of electronic equipment to China.

[57] See *Nihon Keizai Shimbun*, Jan. 26, 1985, p. 7.

[58] See "Japanese Held for Selling U.S. Fighter Secrets," *Financial Times* (London) May 21, 1987, p. 3.

[59] The United States and Japan have, however, recently worked out an arrangement to permit the export of such technology to the United States. See U.S. Department of Defense, *Japanese Military Technology: Procedures for Transfers to the United States*, Feb. 1986.

[60] Import certificate from the foreign government and delivery verification.

Europe's export policies have evolved in keeping with this philosophy. Exports will be approved unless there is a good reason to refuse them. This evolution has led to a recognition that China can be treated quite differently from the Soviet Union without affecting international security. China is technologically far behind the Soviet Union and so could not achieve the same strategic advantage from sophisticated imports; it will have limited ability to threaten even its neighbors for the next few decades. Furthermore, unlike Eastern European countries, China is quite unlikely to pass technology on to the Soviet Union.

When OTA first studied this topic in 1979, the potential for differentiation was recognized, but concern over repercussions from the Soviet Union prevented the implementation of preferential treatment.[61] However, distinguishing China from the Soviet bloc has actually proceeded rapidly. In recent months there has been informal talk in Europe of removing exports to China from the COCOM process. The prevailing sense is that, in general, strengthening China is good for international security because China will counterbalance the Soviet Union, but also that caution should still be taken about advanced technologies with strategic implications.

In all the countries studied here, the export control system is organized to respond quickly, and relations between business and government appear to be less confrontational than in the United States. Each country has a list of technologies, evidently similar or identical to the COCOM list. As mentioned earlier, however, different countries have adopted different approaches to publishing changes to export policies stemming from the 1985 COCOM agreement.

Companies in *Germany* are free to export except under certain conditions; for example, when the technology is controlled by COCOM. Industry is well aware of which technologies are controlled. When a company has such a contract, it applies for an export license. The Foreign Office (Auswärtiges Amt) and the Economics Ministry (Bundesministerium fur Wirtshaft) review the applications and decide if the license has to go to COCOM. If not, the application is completed in a few weeks. German companies can sue the German government if they are not satisfied that a denial was based on a threat to national security.[62]

France has a somewhat more complicated system, perhaps partly because France exports large quantities of weapons and Germany does not. Control is facilitated by the close relationship between government and industry. Export applications are submitted by industry to the Customs Office. If the application involves sensitive technology, it is sent to the Ministry of External Relations and the Ministry of Defense. Some of the criteria used for evaluating an application are:

1. the impact on national security,
2. the impact on international undertakings, such as COCOM,
3. nuclear proliferation, and
4. private-sector concerns, including the impact on industry.

The Directorate of External Economic Relations may play a more promotional role in the considerations. An interministerial committee has been established to assess overall commercial and strategic concerns. Discussions are frequent, perhaps several times a week.

The United Kingdom uses a system similar to the German approach in that companies are free to export unless told otherwise. License applications are handled by the Department of Trade and Industry. An interdepartmental committee, including the Ministry of Defense and the Foreign and Commonwealth Office, discusses the implications of each case of sensitive technology. The committee usually reaches a consensus quickly, but occasionally sends the case to the ministers for resolution. The prevailing philosophy appears to be that exports are good except for a relatively few cases where the reasons to hold back are compelling. Technology transfer to China rarely involves such reasons, though Britain is not prepared to send large quantities of military technology.

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[61] OTA, Technology and East-West Trade, November 1979.

[62] For a more detailed description of European countries export control practices, see OTA, Technology and East-West Trade, November 1979.

In general, these systems are more collegial and less legalistic than in the United States, and are more attuned to approving exports. These differences may result in approval of some exports that would be denied in the United States, but OTA has not been able to document any pattern of major differences in the level of control. Each country (and especially its exporting community) appears to be somewhat suspicious of the others, especially about the interpretations of technical stipulations on exports and the tactics used at COCOM. These suspicions apply to the United States, as well.

AID AND EXPORT FINANCING

Countries supplying technology to China have also developed different approaches to promoting trade and technology transfer. Some countries, such as Japan, have established extensive aid and financing programs, whereas the United States has no aid program and only limited official financing.

These diverging approaches stem from different views about the proper role of government in trade and technology transfer. While the general predilection in the United States has been to limit the role of government in technology transfer, except where national security is at stake, in practice many reasons have been used to justify positive intervention. Strengthening the economies of developing countries friendly to the United States and promoting U.S. commercial interests are among those that have been applied to support large aid programs in countries like Egypt or export financing for sales of U.S. aircraft overseas.

Although some of the major suppliers appear more willing to use aid and financing, these policies are the subjects of ongoing debate and revision. There is a good deal of variation in the mechanisms used. Britain, for example, has recently inaugurated a large financing program for China. Science and technology and student exchanges have been prominent in U.S. Government policies. As with export controls, however, differences in promotional policies are much more differences of degree than kind.

It is difficult to evaluate the commercial advantage accruing from promotional programs. However, in some cases large aid or financing programs have opened the door for national firms to contracts that probably would not have been possible otherwise.

Still, the interplay of commerce and aid raises some knotty questions. There is a danger that the supplier governments, by providing extensive financial support or "tied" aid programs, up the ante for participation by all foreign firms. The Organization for Economic Cooperation and Development (OECD) countries have attempted to deal with the problem by setting guidelines for export credits. Such agreements, however, are hardly all-encompassing. The United States, in particular, has pressed for a higher grant element in mixed credits that combine official export financing with overseas development assistance.[63] Given the severe budgetary constraints in the United States, large-scale financing programs abroad (especially those involving mixed credits) are viewed with concern.

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[63] In 1986 there were numerous reports of disagreements among the OECD countries on mixed credits. See "Aid, Trade and Subsidies," *Financial Times* (London), May 3, 1986, p. 16.

Development Assistance

Japan

Since 1979 Japan has supplied more than $1.5 billion of official development assistance (ODA) to China, 52 percent of the aid from all sources, including multilateral organizations.[64] The International Development Association of the World Bank was the second largest source of aid (14.6 percent); the third was West Germany (13.2 percent).[65] The United States provides no bilateral ODA to China.

By 1982 China had become the number-one recipient of Japanese ODA. In 1985 Japan provided China with $388 million of ODA (on a net disbursement basis). Japan's large aid program in China reflects not only the Japanese Government's high priority on aid to China, but also the growth of its aid program worldwide. By 1984 Japan took second place behind the United States among the major development assistance countries (DACs).[66] Japanese leaders pledged to double ODA again during the next 7 years. In 1985, however, Japan's ODA fell by 12.1 percent from the previous year.[67]

The level of ODA, however, continues to be a point of some dispute among government agencies, one fought out in annual budget cycles. The four key agencies are the Ministries of Foreign Affairs (MOFA) and Finance, MITI, and the Economic Planning Agency (EPA). The Overseas Economic Cooperation Fund (OECF), which administers loans, reports to EPA, whereas the Japan International Cooperation Agency (JICA), which provides grants and technical assistance, is under the jurisdiction of MOFA. The Export-Import Bank also plays a role in that it provides loans to Chinese and Japanese corporations involved in development projects. Not surprisingly, the cost-conscious Ministry of Finance tries to keep a lid on expenditures, while MOFA advocates a stronger aid program.[68]

Japan increased technical assistance by 14 percent. Multilateral aid increased, but the grant element fell slightly and remained below the OECD goal. The OECF provided $308 million in direct loans for projects in China.[69] Loans for commodity purchases made up about $133 million of this total. Between 1981 and 1984 more than $522 million of such commodity loans were provided by OECF for China.[70] These loans have generally been provided at 3 percent interest, with repayment over 30 years. Such commodity loans supported purchases of equipment at the Baoshan steel plant and the Daiqing petrochemical refinery. The purpose of commodity loans is to assist countries facing severe balance-of-payments imbalances or shortages of hard currency.

The bulk of Japan's official direct loans to China, however, were in the form of project loans to support development of economic and social infrastructure, such as telecommunications and transportation systems. These loans cover procurement of goods and services for specific projects. Between 1980 and late 1983, Japan provided support for six large projects in the first round of project aid. Total funding for these projects came to over $800 million. The projects include three: to develop railroads, a hydroelectric plant, and two ports. Under the second round of projects, Japan has pledged to provide another $2 billion to support seven large projects. Among these is one to develop telecommunications in Shanghai and other cities.

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[64] "Chugoku ni tai suru Gaikoku Enjo no Doko" [Trends in Foreign Aid to China], *Kikin Chosa Kiho* [The OECF Research Quarterly], No. 49, June 1986, p. 185. (Based on OECD data.)

[65] Between late 1981 and early 1985 the World Bank loaned China more than $2.3 billion ($1.3 from International Bank for Reconstruction and Development and $1.0 from International Development Agency). See Nihon Kogyo Ginko [Industrial Bank of Japan], *Saikin no Chugoku no Seiji Keizai Doko* [Recent Political and Economic Trends in China], Oct. 24, 1984, p. 33.

[66] Development assistance countries, as designated by the OECD.

[67] One reason for the decline was that committed loan funds were not used in many cases because recipient nations were unable to provide matching funding. The decline in Japanese aid during 1985 probably pushed Japan back into third place behind France (and the United States) in terms of aid contributions.

[68] In late 1985, the Ministry of Finance argued that Japan's ODA should be reduced by the same margin as the yen's appreciation against the dollar. See *Asahi Evening News*, Dec. 5, 1985.

[69] Kaigai Keizai Kyoryoku Kikin [OECF], *Gyomu Hokokusho* [Administrative Report], Mar. 31, 1985, p. 10, calculated at $US1 = 231.5 yen.

[70] Calculated at $US1 = 249 yen (1982 rate). See Kaigai Kyoryoku Kikin [OECF], *Chugoku En Shakkin no Gaiyo* [Summary of Yen Loans for China], November 1984.

In principle, Japan's loans for Chinese projects are "untied." That is, firms from other countries are eligible for participation in the projects. Since the early 1980s all announcements for bidding on projects supported by Japanese aid in China have been open in this sense.[71] However, in the early 1980s, significant portions of OECF-supported projects were tied, although in recent years the percentage of tied-aid funding has reportedly dropped to 5 percent. In earlier years, Japanese firms probably won about 60 percent of the goods and services for projects supported by OECF in China. There have been cases however, where U.S. firms have supplied equipment for projects in China that were supported by official Japanese financing.[72] In late 1986, MITI officials were suggesting the expansion of "export-promoting" aid to Asia, a plan that some observers suspected would help primarily Japan's own consultants, builders, and suppliers.[73]

The major thrust of Japan's aid to China has thus been large projects designed to build infrastructure. Generally speaking, these are viewed with pride as examples of successful cooperation. The projects are selected in a process that involves the Chinese first providing a ranked list and Japan responding.[74] There has been at least one case (a dam project) where problems developed that resulted in cancellation, and there have been problems associated with high costs arising from local content and employment requirements. The overall evaluation, from the Japanese side, has been positive, but a report prepared by OECF in 1985 noted bottlenecks in Chinese economic development and called on the government of Japan to improve the efficiency of aid projects in China by focusing on priority projects.[75]

Technical cooperation remains a small part of overall ODA but is growing in importance.[76] These programs are carried out by JICA. More than 200 Chinese have been trained by JICA programs in Japan for up to 1 year, and Japanese experts have been dispatched to China to provide technical assistance. In some cases, materials and equipment are also provided.

An agreement made in late 1985 to send young volunteers aged 20-30 to China for 2-year periods indicates the evolution and expansion of such projects. A "silver volunteers" association has also been set up to support the dispatch of retired Japanese engineers.

Japanese aid officials see "project-type" technical cooperation as their most effective vehicle and have slated these programs for expansion in China. Currently, such programs include a hospital, family planning education, an enterprise management center, a wood utilization project, and a food research center. New starts include a telecommunications training program in Beijing, a fish research center in Shanghai, and an agricultural research center in Mongolia.

Japanese cooperation in China's factory renovation programs has been comparatively extensive, and JICA officials have established ties with the State Economic Commission and gained good knowledge of the status of China's industries in rural areas. However, JICA provides only surveys, and confines its activities to projects that involve transfer of standardized technologies. The Japanese Government thus explicitly leaves transfer of "new" technologies to the private sector. During 1985,

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[71] Ministry of International Trade & Industry, *Keizai Kyoryoku no Genjo to Mondaiten* [The Status and Problems Related to Economic Assistance], 1984. Only a portion of the commodity loans have been "LDC untied"—with participation limited to less developed countries (LDCs) and Japanese firms. See OECD, Chugoku, p. 7.

[72] Discussion with U.S. Trade & Development Program, November 1986.

[73] See Susumu Awanohara, "Meeting the Need," *Far Eastern Economic Review*, Nov. 6, 1986, p. 66.

[74] The Japanese Government has upon occasion refused a project, such as a chemical plant.

[75] Overseas Economic Cooperation Fund report, June 13, 1985.

[76] In 1984 technical cooperation made up only about 3 percent of all ODA.

JICA survey projects in China included three steel plants, one piston factory, and an electric cable manufacturing factory, for a total of five.

Europe

Even collectively, European ODA has been far smaller than Japan's. Table 13 shows the total net ODA contributions of European countries and the subtotals of loans and grants.

European ODA to China increased rapidly from a low base in 1981, but future increases are likely to be more modest. Most European countries already contribute a substantially higher fraction of their national income to foreign aid than do either the United States or Japan, and their rate is not expected to rise greatly. Some, such as France and Britain, are particularly generous with their former colonies or countries, leaving less for others.

Germany is likely to remain the largest donor, in keeping with its position as the largest trader. In 1986 China is scheduled to receive approximately $35 million in financial assistance and an additional $20 million in technology.[77] Typical German projects in China include pipemaking and building materials manufacturing. Other activities support feasibility studies and training.

Most bilateral aid is tied (informally, if not explicitly), or spent on goods and services from the donor country. Typically, 70 percent of the aid is delivered in goods and services, while the rest is spent in other countries. Thus, aid stimulates exports even when the main intent is humanitarian.

Other Types of Financing

Japan

The Japanese Government supports trade and technology transfer to China with official financing made available from the Export-Import (ExIm) Bank. The first loan agreement involving ExIm credits was signed in 1979 and provided $2 billion. But China was forced to scale back its development plans in the early 1980s. In 1981 a financial aid package was arranged that included $430 million in suppliers' credit guaranteed by the ExIm Bank, as well as commodity loans (through OECF) totaling $560 million and commercial loans of $30 million. More recently, in 1984 the ExIm Bank agreed to provide $2.4 billion to finance oil and coal development projects. The ExIm Bank has also provided considerable funding to assist small Chinese businesses to import small-scale machinery and equipment from Japan.[78]

Official export financing has contributed significantly to the growth of Sino-Japanese trade. Suppliers' credits are one form that this financing takes. In 1984, for example, the ExIm Bank provided $85 million in suppliers' credits for the export of technical services required for the Baoshan Steel Works. In this case, the credits were provided directly to the Japanese companies supplying the technology and training programs. In another example, the bank was reported to have provided $300 million for the Japan-China Oil Development Company for the Bohai project.[79]

The ExIm Bank gives no particular preference to projects involving technology transfer.[80] Rather, the goal of bank officials is to serve the political ends of Japan's foreign policy by ensuring that those official projects selected have sufficient funding. Therefore, while technology transfer is not an explicit goal, ExIm funding has importantly supported it. In the early 1980s ExIm funding was crucial to the financing of some projects even as overall funding was scaled back.

Private sources are also providing considerable financing. In 1980 a consortium of Japanese banks offered $8 billion in credits. In early 1985 the Bank of Tokyo and related Japanese private banks signed a $2 billion loan

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[77] China Business & Trade, Vol. VII, Issue 23, June 9, 1986.

[78] For an excellent review of Japanese financing for projects in China, see Hong K. Kim and Ricard K. Nanto, "Emerging Patterns of Sino-Japanese Cooperation," *Journal of Northeast Asian Studies*, Fall 1985.

[79] "Tokyo Grants Soft Loan for China Oil Project," *Financial Times* (London), Jan. 15, 1986.

[80] Interview with Export-Import Bank of Japan, November 1985.

Table 13.—European Official Development Assistance to China (million U.S. dollars)

	Total ODA net			Loans net			Grants			Tech. coop grants		
	1983	1984	1985	1983	1984	1985	1983	1984	1985	1983	1984	1985
Belgium	6.0	5.6	6.8	5.9	5.2	6.1	0.2	0.4	0.8	0.1	0.3	0.4
Denmark	5.2	2.2	8.3	4.3	1.5	6.7	0.9	0.6	1.6	0.9	0.6	0.7
France	4.7	6.0	6.3	—	—	—	4.7	6.0	6.3	4.7	6.0	6.3
Germany	96.7	57.5	97.6	84.1	41.5	77.0	12.6	16.0	20.6	12.6	16.0	20.6
Italy	11.1	9.9	14.4	1.0	3.9	3.2	10.2	6.1	11.2	3.0	6.1	6.0
Norway	5.8	11.9	3.6	—	—	—	5.8	11.9	3.6	0.9	0.7	0.6
Sweden	0.6	0.8	11.4	—	—	—	0.6	0.8	11.4	0.2	0.8	1.5
United Kingdom	0.3	0.8	1.6	—	—	—	0.3	0.8	1.6	0.3	0.8	1.6
Other	0.4	0.3	3.1	—	—	2.1	1.0	1.1	0.9	0.6	0.9	0.6
Japan	350.2	389.4	387.9	299.1	347.9	345.2	51.1	41.5	42.7	20.5	27.3	31.2

SOURCE: Geographical Distribution of Financial Flows to Developing Countries, OECD, 1987.

agreement. The loans are to be repaid over a 10-year period, at interest rates of 0.25 to 0.375 percent over the London Inter-Bank rate. In 1985 it was reported that private Japanese banks had expanded their credit lines to China to $2.5 billion, from $1.7 billion in 1984. The Industrial Bank of Japan (IBJ), for example, had credits amounting to $250 million in 1985, while its Hong Kong-based subsidiary had another $150 million.[81] In 1985 three Chinese organizations were reported to have raised more than 140 billion yen on Tokyo capital markets by issuing bonds.[82]

In addition, China has concluded hundreds of compensation trade agreements with firms from Japan, the United States, and West Germany, among others.[83] In the late summer of 1986, it was reported that Japan's trading houses anticipated that they would have to accept Chinese goods in return for about 30 percent of all exports, and that by 1987 such trade would reach more than 50 percent of total exports.[84] The rise of such indirect financing can be explained by scarce foreign exchange in China, the emergence of regional borrowers in China, and limited foreign response to appeals for direct investment. Private Japanese banks are adopting new approaches in China. At least two leasing companies have been formed as joint ventures, with Japanese banks participating.[85]

The interrelationship of aid and trade is complex and controversial. At the heart of the controversy is a tension between the principle that aid be primarily motivated by altruism and the obvious commercial spinoffs that often accrue to firms from donor countries. Large OECF-financed Chinese projects, for example, are generally viewed as Japanese projects in China, despite their official untied status.

Differences in perspective are apparent both within Japan and between the major summit countries. In late 1985 MITI and MOFA disagreed over the use of mixed credits for a coal-fired thermal power generation project in Tianjin. MITI favored using mixed credits to support the bid by C. Itoh and Hitachi to win an international tender against foreign firms. MOFA, however, objected on the grounds that an annual ceiling for yen loans to China had already been fixed and that the use of such loans would likely stimulate foreign criticism. MOFA won this interagency dispute, but the two ministries continue to disagree on this issue.

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[81] "Japanese Financial Institutions Increase Credit Lines to China," *Japan Economic Journal*, May 14, 1985.

[82] An agreement between Japan and China permits buyers of Chinese bonds issued in Tokyo to claim a tax credit of 10 percent of the value of the coupon rate. China does not tax the income paid to subscibers of such bonds. Therefore, the effect is to raise by 10 percent the real value. See Charles Smith, "Borrowers of Last Resort," *Far Eastern Economic Review*, Apr. 24, 1986, p. 79.

[83] See U.S. International Trade Commission, *Assessment of the Effects of Barter and Countertrade Transactions on U.S. Industries*, October 1985, pp. 47, 129.

[84] In a growing number of cases third country barters are also involved. The same article reported that a major Japanese trading house began purchases of Indonesian plywood for reshipment to China, and was reportedly paid in raincoats. See Bruce Roscoe, "Demonetised Deals," *Far Eastern Economic Review*, Aug. 28, 1986, p. 48.

[85] The Daiichi Kangyo Bank expanded its control of stock and management of the Shejiang First Bank, a leading Hong Kong bank with Shanghai participation.

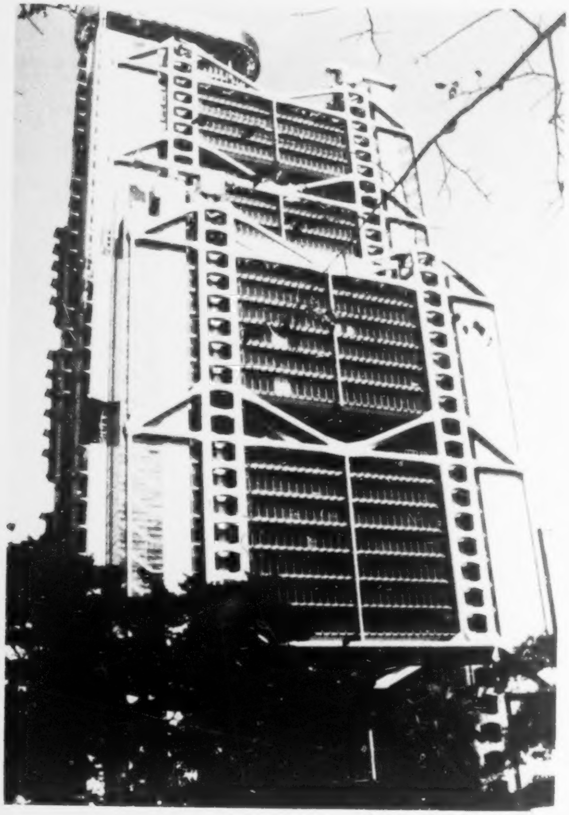

Photo credit: Eric Basques

Hong Kong headquarters for the Hong Kong and Shanghai Banking Corp., an economic powerhouse in the region. This building, recently completed, cost over $1 billion to build.

Europe

All major European countries offer official financing but differ greatly in the degree of involvement and in the use of subsidies. In Germany most financing has been done privately, but the Kreditarstalt für Wideraubau supplies long-term export credits and aid for developing countries.[86] Typical German export-financing interest rates are at or above the negotiated OECD rate. Germany has opposed the use of subsidies for exports but has also been known to resort to them in highly competitive situations.

France has been much more aggressive in the use of official financing. Virtually any export is eligible for official financing and, frequently, subsidies. Often, some of the money is provided by a commercial bank at prevailing rates and the rest (50 to 70 percent) by the Banque Franaise du Commerce Extérieur (BFCE) or the Banque de France at a subsidized rate of 6 percent. In 1979 BFCE offered one of the first credit lines to China, over $3 billion. At that time, however, China was very reluctant to assume debt, and only 6 percent was used.[87] France is the initiator and the greatest user of mixed credits.

Great Britain also has a comprehensive program to provide export credits, but it makes greater use of commercial banks and has reduced the prevalence of subsidies. The Exports Credit Guarantee Department of the Ministry of Trade and Industry is the major contributor for both financing and investment insurance protection. Loans are generally at the OECD rate, but in recent years the market rate has been higher, as in Germany. Thus a subsidy is applied to the difference for the commercial bank. The turbine-generators for the Daya Bay nuclear plant will be financed with 200 million pounds from a consortium of banks. Britain has a mixed credit program under the Overseas Development Administration, even though Britain officially opposes the concept.

Many European commercial banks have established branches in China in hopes of increasing business. Few of these hopes have been realized. Not only has borrowing grown slowly, but most foreign funds have been funneled through Hong Kong banks. However, Chinese policy on debt has been changing, and it appears likely that borrowing will be increased significantly, though not to the extent of other developing countries. A large fraction of this debt would have to be with commercial banks, since official financing is limited.

China is also starting to raise money by selling bonds. In 1986 the Bank of China issued $200 million Eurodollar floating-rate bonds through a German bank syndicate. The Bank of England had opposed the sale in Britain because China was still in default on prerevolutionary bonds issued in London.

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[86] For a more complete description of all these financing systems see: OTA, "Technology Transfer to The Middle East," September 1984, or "Report to the U.S. Congress on Export Credit Competition and the Export-Import Bank of the United States," Export-Import Bank, September 1985.

[87] Dennis Phillips, "Mixed Credits Key to Success," China Trade Report, June 1985.

The Mixed Credit Controversy

Subsidized financing—soft loans—has been used for years. Mixed credit financing, the blending of foreign aid and official export credit, has been used by many European countries and Japan to support their exports to China. The high unemployment rate in most European countries has been a strong incentive to seek means to promote exports.

The reported use of mixed credits increased in 1982 to $4.6 billion worldwide,[88] a small fraction of both total aid and financing. Nevertheless, the potential that mixed credit has for distorting economic decisionmaking is considerable (developmental projects could be ranked on the basis of commercial benefits to the donor nation), and the appearance of receiving discounts may lead to rapidly increasing demand by recipients.

China has pressed Western governments to use soft financing, and mixed credits are a convenient way to comply.[89] However, when almost all suppliers offer them, the result can be intense competition that benefits no one, not even recipients, since presumably the total amount of foreign aid may not rise appreciably. A total of 15 OECD countries now offer mixed credits.[90]

France has been at the forefront in the use of mixed credits. France first used mixed credits ($190 million) in China in 1985 to win a contract to refurbish China's telecommunications system, a project that could lead to a total of about $400 million in telephone and telecommunications contracts.[91] It also used mixed credits to sell three A310-200 airbuses in 1985 for $272 million.[92] France argues that mixed credits help stretch foreign aid, especially in countries that cannot afford to fund projects commercially.[93]

Great Britain has pledged 300 million pounds in soft loans at 5 percent interest for Chinese trade.[94] Britain feels this program is necessary because of the increasing use of mixed credits by its competitors. Some of the first uses will be for a diesel engine plant and telecommunications projects. Belgium, Denmark, Sweden, and Italy have made loans at interest rates as low as zero percent. Italy has been one of the biggest users of mixed credits in China. Two projects are being financed from a combination of $40 million in soft loans and a grant of $10 million: the construction of a tractor plant by Fiat and a power transmission line.[95] Even West Germany has overcome its aversion and is subsidizing a loan of DM140 million for the constuction of several plants. In most cases, the subsidization for all these soft loans will be in the form of mixed credits, or the differences will be procedural more than substantive.

After prolonged disagreement, the OECD countries reached an agreement on mixed credits in March 1987. The new rules make it more expensive for countries to subsidize export credits by raising the minimum level of grant (concessional) financing allowed. The minimum permissible level of aid in a mixed credit will rise from 25 percent to 30 percent in July of 1987 and to 35 percent in July 1988. Minimum interest rates for commercial loans that benefit from mixed credits have also been modified to eliminate or reduce subsidies for certain groups of developing nations.[96]

As discussed in chapter 8, the United States established a "war chest" that permits the U.S. Government to use such credits in cases where other countries offer "predatory" financing. To date, however, the United States has not used mixed credits to support China trade. The OECD agreement may serve to set limits on mixed credit financing by the major supplier countries. In the past, it has been difficult to ascertain the actual extent of mixed credit financing, much less to evaluate the impacts on a country's export performance. The agreement addresses one type of export financing competition, but supplier countries remain free to provide high levels of aid funding or official credits. Japan's projects indicate that even in the case where aid is "untied," domestic firms stand to benefit. Chinese officials have indicated their intention to seek more soft loans from foreign governments.[97] Therefore, linkages between aid and commerce are likely areas of competition among the major supplier countries doing business in China.

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[88] OECD, "Twenty-five Years of Developement Co-operation," 1985.

[89] See Robert Thomson, "China in Bid to Set Up Steel Plant Venture," *Financial Times* (London), Apr. 24, 1986, p. 8.

[90] Janet Robson, "Can America Win La Guerre?," *Euromoney*, March 1986.

[91] See David Housego, "France Paves Way for China Telecom Deal," *Financial Times* (London), Apr. 17, 1985, p. 1.

[92] China Business & Trade, Apr. 23, 1985.

[93] Euromoney, op. cit.

[94] Christian Tyler, "UK Cheap Credit for China Proves Hard to Allocate," *Financial Times* (London), May 2, 1986.

[95] China Business & Trade, June 23, 1985.

[96] See "OECD Nations Ratify Agreement to Limit Use of Tied Aid in Subsidized Official Credits," *International Trade Reporter*, Mar. 18, 1987, p. 366.

MULTILATERAL POLICY CHALLENGES

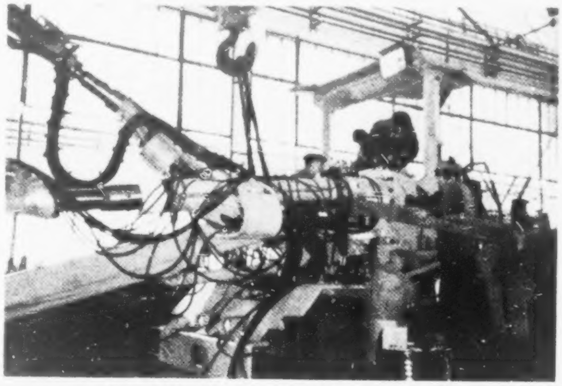

Photo credit: Alice Davenport, and The China Business Review

The Nanjing Construction Machinery Plant has contracted with a Swedish firm to assemble these drilling and boring machines in China, using a mix of Chinese and foreign parts.

Large technology transfer projects to China often involve firms from a number of different countries. The requirements of large projects for finance and specialized technology make technology transfer increasingly a multilateral effort. There are thus opportunities for participation by a number of supplier countries with somewhat different approaches to technology transfer.

In the future, however, the multilateral nature of technology transfer to China may also pose some policy challenges. If China's economy is to develop, exports will increase. A pending issue is whether the supplier countries will be equally willing to permit imports from China, or whether protectionist measures will be taken in some cases.

Another set of questions concerns the strategic dimensions of high- technology trade in the Pacific. As Singapore and other third countries play a growing role (along with China), it may be more important to revise and extend the system of multilateral export controls to ensure their effectiveness in slowing the transfer of technologies with military significance to the Soviet bloc.

The challenge of the future will be to encourage China's smooth integration into the Asian and global marketplace. This will occur in the context of China's entry into multilateral institutions such as the Asian Development Bank and the General Agreement on Tariffs and Trade. Each such step brings with it new policy challenges for the Western countries, since there will be important implications for global trade patterns and political as well as economic effects on other Asian countries.

Growing economic interdependence between the developed and the developing countries underscores the critical need to promote economic growth in the developing world markets. Increasingly, this task requires international cooperation, with Japan taking on a growing role as a capital-rich country. Indicative of these changes was the International Monetary Fund's announcement of its first loan of about $700 million to China in late 1986. While the major Western suppliers will continue to compete for the Chinese market, they may also have to cooperate in certain areas in order to promote China's full economic integration.

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[97] The *China Economic News* reported on Jan. 5, 1987 that Ministry of Foreign Economic Relations and Trade announced that China has recently borrowed soft loans from 15 developed countries and had put to use loans totalling $5 billion in 1986.

Chapter 6

China's Economic and Political Trends

Photo credit: Eric Basques

This magnificent bronze lion is one of a pair that guards the entrance of the Gate of Supreme Harmony in The Forbidden City in Beijing.

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Chapter 6

China's Economic and Political Trends

The recent dramatic changes in China's economy, polity, and foreign policy, have been discussed in chapters 2 and 3. Despite frequent assertions by China's leaders that current policies will continue, many observers have raised the question of the stability of China's new course and China's prospects for achieving its modernization goals.[1] Will the trends of the last 6 to 8 years continue, or is China likely to go on a markedly different course? These questions cannot be answered without considering the prospects for economic performance.

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[1] See for instance, Daniel Southerland, "Party Leader Says China To Extend Economic Reform," *The Washington Post*, Sept. 24, 1986, p. 1.

POTENTIAL LONG-TERM ECONOMIC GROWTH

In considering the overall prospects for the Chinese economy, it is useful to distinguish between the prospects for growth, for reform, and for structural change. Growth is the quantitative expansion of total physical output. Reform refers to the reorientation and revitalization of economic organizations and behavior. Structural change deals with a substantial movement of the work force out of agriculture and an increase in the size of the service sector. In contrast to past efforts to promote economic growth through increases in direct capital investment, present Chinese leaders are trying reform and structural change as well as expanded use of domestic and foreign technology.

Most analysts of the Chinese economy agree that the prospects for economic growth are promising, particularly in view of the changes that have been introduced since 1978. At the same time, there is also a clear recognition that China's growth trajectory could be seriously altered by a number of factors, some of which have to do with environmental factors while others are related to the pace and extent of political and economic reform. Of course, a modest degree of economic growth is possible without further economic reform. Yet, as shown in chapter 3, the majority of problems that confront China's economic policymakers are systemic in nature. To achieve a sustained pattern of growth, a number of modernizing reforms are definitely required. It will become progressively more difficult for the Chinese economy to grow solely on the basis of "extensive" means—i.e., increased capital investment. Thus, in assessing the prospects for economic growth, the potential success of the current reforms in economic and technology affairs must also be addressed.

In effect, there are two schools of thought regarding China's economic potential and the role of reform. One school focuses on the progress resulting from the changes to date in the organization and ideology that underlie the economy.[2] Indeed, there is no doubt that reforms have gone quite far, especially in agriculture, toward reducing the inefficiencies associated with the former Soviet-style economic approach. Many of these reforms are now irreversible and have become fully incorporated into the prevailing economic structure. Based on the apparent success of these reforms and on the improvements in economic performance apparently derived from these reforms, it can be argued that similar growth rates will be sustainable for the rest of the century.

The other school takes a much less sanguine view of the long-term efficacy of recent economic changes, arguing that despite the immediate changes that have been introduced,

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[2] For example, see Dwight Perkins, *CHINA Asia's Next Economic Giant* (Seattle, WA: University of Washington Press, 1976).

Photo credit: McDonnell Douglas Corp.

The interior of an MD-82 twin-jet transport being built under a coproduction agreement between McDonnell Douglas Corp. and the Shanghai Aviation Industrial Corp. The first of the 25 planes should fly in 1987.

"the Chinese economy still retains the basic institutional organization, functional operations, and problems, or results, of a Soviet-type economy."[3] While acknowledging the improved performance of the economy, proponents of this perspective suggest that most of the economic gains since 1978 have been achieved through nonreplicable or one-time changes in agriculture. In this view, the foot-dragging, obstructionism, and resistance apparently hindering the implementation of the industrial reforms, suggests that further reforms are not inevitable and the prospects for rapid, sustained economic growth remain uncertain.

The difficulties with industrial reforms come when the reform coalition in the Chinese leadership has become more vulnerable to criticism from the more conservative members of the elite, owing to perceptions that the central government was steadily losing control over the economy. While there remains almost unanimous agreement on the need for reform among all of China's leaders, continued differences over such issues as the pace, the targets, and the scope remain important. Events during 1985-86, including the rapid depletion of foreign exchange, continued high rates of investment, excessively rapid growth, and reduced grain production, have led to greater caution in the implemention of the reform program. This caution is likely to remain characteristic of Chinese economic policy during the Seventh Five-Year Plan and could be exacerbated as a result of the post-Deng succession process. Thus, even though they are essential, the more difficult reforms in the area of prices, labor, and capital markets will proceed at a more gradual pace than perhaps initially intended.

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[3] Robert F. Dernberger, "Economic Policy and Performance," *China's Economy Looks to the Year 2000* (Washington, DC: Joint Economic Committee, May 1986).

Yet, even taking into account the consequences of a more gradual approach to reform for economic growth rates for the rest of the century, most observers agree that the quantitative dimensions of economic performance are likely to be respectable. The range of projections (discussed in app. 1 of vol. II of this report) is shown in table 14. Two factors affect the projections (in addition to problems with the reliability of Chinese data). First, the perceptions reflect the differences in modeling techniques and the nature and currency of the data used by the respective researchers. Models inherently contain biases, especially because they deal with interrelationships among the economic variables and the role assigned to various key sectors. For example, the models differ in their assessment of the projected contribution of agriculture, with the Lau model suggesting a much more modest role than does either the World Bank or Rock Creek.

Second, the projections reflect the explicit and implicit assumptions of the respective researchers about the workings of the Chinese economy and their interpretation of the likely contribution the reforms will make to present and future economic performance. The base projections in the Lau model are firmly rooted in China's Maoist era experience, for example, whereas the World Bank depends on causal relationships mainly extrapolated from the experience of other developing countries. Similarly, the projections contained in the Rock Creek models give more weight and importance to China's recent experiences under the Dengist reforms.[4] These differences account for the more optimistic projections of Rock Creek, which goes further than either Lau or the World Bank in incorporating China's output and productivity growth up to the mid-1980s into its model. Thus, implicitly, if not explicitly, it assumes fewer problems with the reform effort in the future.

As presented in table 14, the three models project average growth rates ranging from 6.6 to 8.7 percent through the end of the century. China's goal of quadrupling the value of the GVIAO (Gross Value of Industrial and Agricultural Output)[5] would be met in all these scenarios. More conservative estimates might see an average annual growth of 4.5 percent in the future, which would still almost quadruple GVIAO because growth since 1981 has been above the target rate.

Such high growth rates for extended periods of time would be very unlikely in an industri-

Table 14.—Comparison of Real Gross Domestic Product Growth Projections, 1981-2000

	Agriculture	Industry	Other	Total
World Bank Quadruple	4.9	7.1	7.6	6.6
World Bank Balance	4.4	6.0	9.2	6.6
L. Lau High Scenario	3.4	7.9	6.7	6.7
Rock Creek Research Low	5.7	7.7	9.3	7.8
Rock Creek Research High	5.7	9.3	9.8	8.7

SOURCE: Rock Creek Research, Inc., *The Role of Technology Transfer for China's Economic Future*, app. 1, vol. II of this report.

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[4] Rock Creek Research, Inc., *The Role of Technology Transfer for China's Economic Future*, app. 1, vol. II of this report.

[5] GVAIO grows faster than gross domestic product (GDP) because it includes double-counting of intermediate inputs that increase with time as a country develops. Thus, by focusing on quadrupling the GVAIO, the Chinese will not have to quadruple GDP.

alized country, but Japan in the 1960s and South Korea and Taiwan in the 1970s achieved such growth levels. In contrast to the majority of less developed countries (LDCs), China has a strong resource base; a literate, moderately disciplined work force; and a high savings rate. There is a significant capital stock in place, though much of it is dated. There is also a significant science and technology infrastructure. Finally, there is a national commitment to growth and modernization at the highest levels, which is more characteristic of the newly industrialized countries (NICs) than of most developing countries, or China of a decade ago.

The "qualitative" dimensions of economic growth in China must also be considered in addressing the prospects for improved economic performance. This would include issues such as the composition of growth and the role of technological change. In others words, it is important to consider where China's growth might come from and how it will be achieved. Chinese economic performance during the last 5 to 7 years has been buoyed by the achievements of the agricultural sector. There are some signs that agricultural growth rates may not be able to match those of the recent past, however, owing to external diseconomies (loss of farmland to housing construction, neglect of infrastructure—i.e., irrigation systems—neglect of agricultural extension services, and a slowing of the technical modernization of agriculture) that result in diminishing returns. At the same time, some of these trends could be reversed, according to the Rock Creek projection, through the switching of cropland out of low-value-yielding grains into vegetables and fruits with an enormously greater yuan output per hectare.

Technological change as a result of technology imports will also be an important factor affecting growth, though in all but the Rock Creek high-growth scenario projections noted above, they seemingly are not assigned a critical role. In the Rock Creek low-growth scenario, for example, even with only modest improvements in technology, the Chinese economy still promises to grow at a rate faster than the official Chinese projections, attaining the quadrupling goal by 1995, not 2000. As suggested, in this model, a good portion of this growth will come from agriculture. Both the World Bank and Rock Creek agree that trade will also be an important component of growth. In the case of the latter's projections, industries such as consumer electronics will play a significant role, fueled in large part by greater technical sophistication and improved product quality.

It is only within the Rock Creek high-growth scenario that foreign technology imports are incorporated as a key determinant of economic performance. This projection is based on the assumption that China acquires and absorbs a range of technologies that markedly raise productivity and output quality throughout the economy, especially in the machinery and consumer manufacturing sectors. The major beneficiary of successful technology assimilation will be the industrial sector, which could improve its performance capabilities beyond the Lau, World Bank, or Rock Creek low-growth projections. The implications of such a high-growth pattern would be particularly important in the trade area. According to the Rock Creek analysis, if China were to make optimal use of foreign technology imports, it could dominate the apparel export market, replace South Korea as the source for most basic consumer and some sophisticated electronics products, and even begin to export automobiles to Third World countries.

Without delving further into the underlying dynamics of the various estimates discussed in this section, it appears that the outcomes at either extreme, very low growth and very high growth, are unlikely. For either to occur would require a confluence of numerous factors to either strongly inhibit or greatly facilitate economic performance. The high growth rates since 1980, which have surprised many analysts, could continue, but a plethora of factors could negatively affect economic performance and the success of technology transfers. Barring any drastic change in current Chinese borrowing practices, China's foreign exchange shortage is likely to be a major constraint on large-scale importation of technology and equipment. Combined with existing bottlenecks to effective assimilation of technology, these factors could become significant obstacles to growth in the 1990s if appreciable progress is not made in alleviating them during the Seventh Five-Year Plan.

Other issues also raise questions about China's economic future. Reform of the urban economy has proven to be difficult, and incomplete reforms could be damaging. The reform program has also contributed to the rise of socially undesirable behaviors that could discredit the reforms and therefore slow them down. Along with the political factors that will be discussed in the next section, these include urban protests, corruption, and increased inequality. The Chinese will also have to be concerned with labor indiscipline and will have to find ways to alter the sociology of the work unit (*dan wei*). As described in chapter 3, the proprietary claims on technology and personnel made by the work unit are among the most debilitating obstacles to technology diffusion. Tensions between the central authorities and local governments, especially in the area of finance, will also have to be changed.

Some of these factors will affect China's growth trajectory, more than others, though here again, even in combination they do not necessarily portend significantly low economic performance. What is likely until the turn of the century is a China still beset by numerous economic fragilities, but one able to sustain a pattern of growth range of 6 to 7 percent. This growth rate will not be distributed evenly throughout the economy: a few sectors across this broad-based economy will reflect the fruits of modernization while the remainder of the economy lags significantly behind. Textiles, consumer electronics, machinery, and agriculture will continue to be important in this regard. The major economic question facing China for the rest of this century, therefore, will be the extent to which these few leading sectors can pull the rest of the economy forward versus the degree to which the backwardness of the other sectors will slow down the overall rate of growth for the entire economic system.

It is clear that some of the most important constraints on future economic performance will be economic and technological. However, political stability and reform are also crucial factors influencing the prospects for modernization. The course of domestic politics is also important in considering China's foreign policy, its open door to foreign investment and technology, and its role in international security affairs (which are discussed in the next chapter). Finally, questions about the future of Chinese politics are all the more important in light of China's recent history of social turmoil and political cleavages.

FUTURE POLITICAL EVOLUTION

Despite uncertainties about the depth of conservative opposition to the pace of reforms, it appears that the general direction of China's current course in economic policy is unlikely to change drastically. Although the current leaders have major internal differences, they share a common commitment to reform and modernization.[6] The range of foreign opinion is considerably broader on China's ability to manage what all observers would agree are enduring political problems. Until recently, the reform coalition was effective in managing divisive issues. At present, however, there are obviously serious divisions within the leadership over policy, especially the pace and extent of reform. Underlying these divisions are questions about the limits of reform in a system dominated by a Leninist party, and the future role of ideology in a society that has been so driven by ideology (with many unfortunate consequences) in the past. The lower ranks of officials and managers, some of whom have actively resisted reform, will also play a crucial role.

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[6] See Thomas Fingar, "Politics, Policy, and China's Future Course," app. 7, vol. II of this report; and Charles F. Steffens, "Leadership Changes in China and Their Implications for the United States," U.S. Library of Congress, Congressional Research Service, CRS 86-131 F (June 24, 1986).

Clearly, China's current course and its recent accomplishments owe much to the presence and leadership of Deng Xiaoping. Many questions have been asked, therefore, about the prospects for politics under his successors. Deng and his supporters have clearly tried to plan for political leadership in the post-Deng era, and have brought into second and third echelon leadership positions younger, better educated individuals who seemingly share Deng's reform values.[7] It will not be clear for many months, or even years, whether these efforts to ensure continuity will be successful.

Even if the reformers prevail over the more doctrinaire elements of the leadership, there will be competition for power and influence. Cleavages are certain to develop based on personal aspirations, factional relations, and policy positions. Regional divisions based on uneven growth are also likely to be a factor in intra-elite politics. How these conflicts will be managed is an important question for the future. There are various signs that the Chinese are trying to make political life less personalistic and more subject to publicly understood laws and rules, and to make elite conflicts less of an all-or-nothing experience. Nevertheless, in light of past experience, there are good reasons to question the extent to which the new political rules of the game have been institutionalized. The effectiveness of political reform, still nascent compared with economic reform, will bear close watching.

The future of Chinese politics bears a close though complex relationship to the course of the economic reform program. On one hand, the future of reforms will require continued political commitment and political stability. Failure of reform will reflect badly on the Dengist leadership and could be a source of political instability.

However if the reforms succeed, China will also face new political challenges. A successful reform program will reinforce the continuation of the open door policy and be a stimulus to modernization; however, modernization will bring with it many new problems. These include the management of demographic and environmental changes brought by modernization, the need to accommodate politically the social and economic pluralism entailed by a successful reform program, the need to respond to rising expectations from the population, and the challenges of managing the commercial and security problems resulting from interactions with the external environment via the open door.

Photo credit: Leo A. Orleans

View of Shenzhen, a special economic zone. In the background is Hong Kong. Eight years ago this was a fishing village surrounded by rice paddies.

One of the more intriguing questions about China's political future is the likelihood of democratizing and liberalizing trends. The post-Mao period has clearly seen some evidence of change in the political climate, and the leadership itself refers to the need for democratization, although it is by no means clear what that term means to those who use it.

The liberalization that has occurred has been within the established Marxist-Leninist framework. From the viewpoint of the Western liberal tradition, this liberalization would appear to be minimal. Yet relative to the period preceding it (1958-77), the tone of political life has clearly changed for the average Chinese. There is more freedom of speech, and the Party shows new tolerance for appeals from the population for the rectification of official abuses (though this tolerance has limits, as shown by the crackdown on the student demonstration in January 1987). The election of leaders in work units is encouraged, and competitive elections for local people's congresses have been tried. The National People's Congress has emerged as a more active representative body within which Government policies are debated and legislative proposals from the executive are modified. Finally, the press has become a more lively forum for the airing of different opinions, although it has by no means become free of political supervision.[8]

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[7] Steffens, op. cit.

At the center of the uncertainties about Chinese political change is the question of the future role of the Chinese Communist Party. In the past, the Party has run the affairs of the state—both macro- and micro-management of the economy, culture, and ideology--and was the sole route to material gain and upward social mobility. The environment created by the reforms is inconsistent with these roles. An objective of economic reforms is the reduction of political influence in economic management. Administrative reforms have attempted to establish a clearer separation between Party and state. The ideological bases for policy are shrinking, and ideology has become a less salient factor in Chinese society and public life. Material benefits are increasingly available to those with money, and the ability to earn money has increased. The prestige and privilege once attached to Party membership no longer seems attractive to large segments of the population.

It is difficult to conceive of the Party allowing itself to whither away. Major questions face the Party: Will it be able to do what no other Communist party has done, and define for itself a new social role that will be compatible with modernization? Or, will it become an ever more conservative force, a drag on modernization, in the interests of maintaining its organizational integrity and control over the society in the face of changes that render it obsolete?

THE IMPACT OF TECHNOLOGY TRANSFER

Impact on the Economy

Without technology from abroad, China will have a slow and costly road to modernization. However, technology is only one function involved in reaching a more efficient economy. Shifting from an extensive to an intensive growth pattern will also require managerial changes and an improved environment for managerial decisionmaking. The economic reforms are clearly intended to alter the economic environment; if successful, they would be an important step in moving toward an effective, intensive growth strategy.

The experiences of Japan and the Asian NICs readily demonstrate the importance of foreign technology transfer to economic growth, especially in certain sectors of the economy; for example, consumer electronics and textile industries. Technology transfer from abroad can also be a force supporting the kind of institutional change sought by the reform program. As illustrated in the Foxboro case described in chapter 4, and as noted in the World Bank's analysis of the Chinese economy, effective technology transfer often involves the transfer of the modern management and general business skills that China needs.[9] Since the Chinese have a stake in importing technology, technology transfer can be (but is not necessarily) a force for overcoming resistance to reform. Successes in reform, in turn, can have positive growth effects, and there is some, albeit still limited, evidence that China is beginning to realize increments of growth through

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[8] Based on remarks by Professor Andrew Nathan, Columbia University, at the SAIS China Forum of the Johns Hopkins School of Advanced International Studies, Washington, DC, Sept. 17, 1986.

[9] The World Bank, *China: Long-Term Issues and Options* (Washington, DC: 1985).

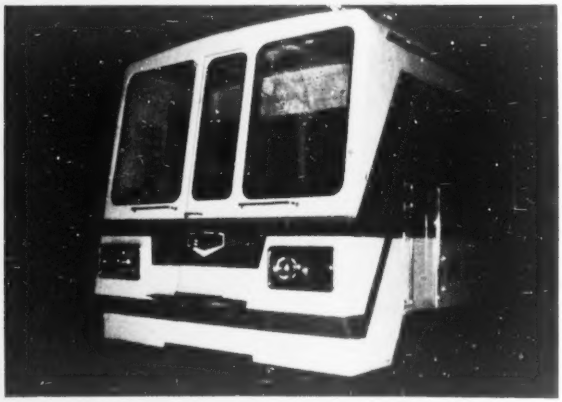

Photo credit: Eric Basques

This modern subway train is being manufactured at the Changchun Passenger Coach Factory. It will be put in service on the Beijing Subway.

"disembodied technical change" (increased output not linked to increased equipment) resulting from reform and new technology.[10]

Over the longer term, as the experiences of other East Asian countries illustrate, technology transfer can have a profound effect on the growth and modernization of an economy, including qualitative changes. One of the more important consequences of technology transfer indeed is likely to be in the improvement of product quality, a change that is closely linked to the question of Chinese export expansion, discussed below. The benefits from technology transfer are more likely to become evident in the 1990s (sooner in some cases), assuming that some of the basic institutional problems of the economy are solved. Growth over the short term is likely to depend on factors other than technology transfer; for example, through high levels of investment[11] and, as reforms succeed, by greater rationality in economic decisionmaking.

Not all effects of technology transfer are positive. Adding an active technology transfer program to an economy that is institutionally ill-prepared to receive and use the technology can lead to reduced growth and economic confusion, as the experiences of countries such as Poland illustrate. The importance of having a receptive institutional environment and the ability to assimilate technology and incorporate it into production is illustrated by the Asian NICs. The existence of these attributes in the latter countries, but perhaps not in China at the moment, should induce caution in comparing China's current course with that followed by the Asian NICs.

China has clearly had technology transfer experiences recently that have not gone smoothly. The transfer of Spey engine technology in the 1970s, for instance, has not led to its effective utilization in Chinese production. The Baoshan steel complex, though now partially completed and operating with Japanese technology, has also run into a host of problems that have required extraordinary efforts to manage and have been a source of ill feeling between China and Japan. Serious problems are also evident in such showpiece projects as the Volkswagon Shanghai Santana venture and the AMC-Beijing Jeep operation discussed in chapter 4. In these and other cases, technology transfer has not gone smoothly, and the efforts have not produced the expected economic effects.

Impact on the Political System

The impact of technology transfer on China's political future is an intriguing question. Western observers often like to think that the coming of modern technology will promote liberalization, the implicit assumption here being that the division of labor and specialization that are associated with much modern technology carry an imperative for pluralizing political arrangements as well. This may be too simple an approach to an assessment of the Chinese political future.

These implications cannot be considered without discussing people—the foreign supplier of technology and the Chinese managers and officials who procure it. China's quest for technology has made the foreigner a participant in Chinese policymaking and thus a factor in Chinese politics. The opinions and analyses of the foreigner often carry weight in Chinese policy deliberations, and access to the foreigner can be a useful political resource for the Chinese decisionmaker.[12] More generally, the West and Western technology have great prestige in China, and are seen as a source of guidance for the modernization program.

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[10] Rock Creek Research, *The Role of Technology Transfer*, app. 1 in vol. II of this report.

[11] Robert F. Dernberger, "China's Development Strategy Investment Financing Needs and Sources," paper presented to the Fifteenth Sino-American Conference on Mainland China, Taipei, June 1986.

But there is ambivalence about the West, about the foreigner, and about foreign technology, as well. The West is seen as the source of corrupting ideas and values, and close relations with foreigners can be a liability as well as an asset.

The impact of technology transfer is also not uniform; the distribution of the benefits from it are uneven. The most notable differential is based on geography, with the coastal regions being more clearly the beneficiaries of the open door policy and the access it has brought to the goods of the foreigner.[13] This privileged position of the coastal region is a consciously chosen part of the Chinese development strategy, which sees these regions serving as a bridge between the advanced technology in the international environment and the more technologically backward interior sections of the country. While there now seems to be a general acceptance of this policy, it has not come without objections from the interior.

As with the impact on the economy discussed above, the impact on the political system could be positive or negative. China's long history of xenophobia, the force of nationalism, the potential for corruption resulting from interactions with the foreigner, and the differential distribution of benefits of technology transfer all make for potent threats to domestic political stability and to continuity in foreign policy.

On the other hand, in China's recent history of interactions with foreigners, and search for foreign technology and investment, there is evidence of positive political change. This includes greater attention to achievement criteria in the recruitment of leaders, efforts to institutionalize a legal system, more rational approaches to policymaking, pragmatism replacing ideology, moderation in the management of political conflict within the elite, and a degree of liberalization, albeit within the terms of Marxism-Leninism.

Impact on Social Change

In contemplating the future impact of technology transfer on Chinese politics, a central issue is the extent to which technology transfer will contribute to social change, which will in turn effect the Chinese political system. One approach to this question is to see the Dengist leadership generally in control of issues of liberalization and the impact of technology transfer. In this view, the liberalizations that have occurred can be seen as part of the political and policy agenda of Deng and his followers. Forms of liberalization can be seen as means to combat the conditions, such as entrenched bureaucratism, that are viewed as threats to the successful implementation of the reform program. To simplify this argument, the Dengists are committed to modernization, including the importation of foreign technology. They realize that economic reform is needed to utilize foreign technology effectively and thus are willing to initiate political changes to overcome resistance to reform. Technology transfer thus has an impact through the planning of the leadership.

A second approach is to see technology transfer as a force for social change that is somewhat beyond the control of the elite. Technology transfer in the context of reform is seen as a pluralizing force. As Chinese society becomes more complex because of technological changes, it has greater difficulty achieving centralized, comprehensive political controls. Access to foreign technology and investment by an increasing number of organizations can be seen as empowering in the sense that it reduces dependence on the Chinese state for necessary resources.

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[12] See Michel Oksenberg and Kenneth Lieberthal, *Bureaucratic Politics and Chinese Energy Development* (Washington, DC: U.S. Department of Commerce, 1986).

[13] This includes access to overseas education. See Committee for Scholarly Communications with the People's Republic of China, *A Relationship Restored* (Washington, DC: National Academy Press, 1986).

Furthermore, certain requisites of successful technology transfer are more compatible with a pluralistic, decentralized social order than with a centralized, monolithic system. If China wishes to have the benefits of the technology, it will have to accommodate these requisites. For example, Chinese approaches to property rights, including intellectual property rights, have been altered by the need for clarity in proprietary claims technology. It is unlikely that China would have created a patent system, for instance, if not for the concern that without one, Western technology would be less available. The concern for patent protection, however, reinforces other trends in the Chinese reform environment that are in the direction of assigning property rights to individuals and groups outside of the sphere of the state. This in turn is part of a trend toward the creation of an economic system that is considerably more independent of the political system. A more autonomous economic system is thought in this latter interpretation to be a check on state power and thus a force for a more liberal order.

These two perspectives—one stressing managed political change from the top and the other seeing political change resulting from social and economic change from below—need not be regarded as mutually exclusive. There is evidence for both interpretations. Perhaps the more significant observation, therefore, is that technology transfer is part of a complex process—involving active elite participation *and* diffuse social change beyond the elite's control—which is forcing political change in directions that could be interpreted as liberalizing.

It is impossible to say whether these trends will continue or whether on balance they are a force for future political stability. There clearly are other forces in Chinese political life that work against liberalization, but more importantly, there is the question of whether liberalization serves Chinese modernization interests or not. While the Western observer might consider the answer to this question to be obvious—modernization cannot proceed without liberalization—a careful reading of Chinese politics would indicate that under certain conditions, some forms of liberalization might have negative consequences.

For, despite an image of monolithic, centralized power, China is in many ways a polity in which authority is fragmented. As noted in chapter 3, there are uncertainties in the authoritative roles of ministries vis-à-vis central planners and the top elite, and of those of local governments vis-à-vis the central government. Other areas of uncertain authority relations also point to problems of fragmented authority.

Modernization-induced change, including the impacts of technology transfer, in principle could create problems for the political system in two ways. First, as a force eroding concentrations of power (the liberalizing influences discussed above), technology transfer could lead to the further fragmentation of authority. There is already evidence, for instance, that the combination of the open door environment and domestic reforms have produced delays (approaching immobility) in decision making on certain large projects where foreign technology would be central, such as Three Gorges, the hydroelectric project.[14]

At the same time, technology transfer, and economic modernization more generally, will create a host of new social problems—new environmental insults, occupational dislocations and employment problems, new infrastructure and social services requirements—that will require effective political responses. A case could be made that more, rather than less, concentration of power and authority might be required, and that without it, technology transfer could increase China's problems of governability and political stability.

There clearly are dynamics of Chinese politics that are beyond the ken of the foreign observer, and that makes predictions and forecasts subject to considerable doubt. The political changes in China since the late 1970s have been important, have pointed toward the likelihood of continued stability, and have been liberalizing to a degree. The increased interactions with the outside world, including increased technology transfer, have been compatible with those changes—the open door has both helped and been helped by the domestic political changes. The trend line therefore is encouraging. By implication, to support technology transfer is to support the trend.

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[14] See Oksenberg and Lieberthal, op. cit.

However, Chinese politics have shown unexpected changes of direction in the past, and may again. In addition, the political role of technology transfer is complex. Modernization can be a disruptive as well as a positive experience. Ultimately, the question becomes whether or not China will be blessed by skillful and dedicated political leaders who can guide the country around the pitfalls of technological change while reaping the benefits of that change.

Market Socialism

The current direction of Chinese institutional experimentation involves greater use of decentralized market mechanisms to stimulate efficiency and innovation as well as more attention to central planning controls. The basic principles of socialist ownership are to be maintained, as are socialist fairness in distribution and socialist welfare and social security principles (although the mechanisms for providing the latter may change).[15] The sanguine view of China's future assumes that these often contradictory elements in China's institutional quest can, in principle, be reconciled into a Chinese form of "market socialism."

The less sanguine view, drawn in part from analyses of East European experiments with market socialism, is that the prospects for an institutional order that is "half plan, half market" are not promising. On certain key issues—prices, workplace motivation, property rights, social security—the approaches of market-coordinated and planner-coordinated systems are simply too divergent.[16] Socialist planners are incapable of tolerating the wide fluctuation in prices, for instance, that will characterize an effectively functioning market system. To achieve the motivational benefits of a market system is to tolerate the use of material incentives leading to significant income inequalities, which again will be incompatible with the socialist orientation. The priciples of economic efficiency underlying the market system contradict the "social contract" or "socialist ethical code" of the socialist system, which stresses such values as the protection of the weak (rather than the value of competition), the interests of the collective (rather than the individual), and full employment (rather than efficiency).[17]

In this view, the "half plan, half market" hybrid is seen as ultimately less desirable than either the market system or the planner controlled system. In addition to contributing to economic disequilibrium, the hybrid also contributes to a disequilibrium in public morality. Individuals faced with the uncertainty of whether they are expected to conform to the norms of the marketplace or to the norms of socialist morality become morally confused and adopt a "live for the day" mentality.[18] The rise of corruption, which China has experienced since the initiation of reforms, may be a result of this moral disequilibrium.

The two views on the prospects for market socialism in China—the sanguine and the skeptical—may both fail to allow for the possibility, and indeed the likelihood, of more incremental, less premeditated, changes in Chinese institutions in response to Chinese conditions. Such changes may defy easy description and are less neat theoretically, but they are more typical of the actual workings of social systems.

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[15] Cf., The World Bank, op. cit., p. xxxiii.

[16] This argument has been made by Jan S. Prybyla. See, for instance, "Mainland China and Hungary: To Market, To Market . . . ." unpublished paper presented to the Fifteenth Sino-American Conference on Mainland China, Taipei, June 8-14, 1986.

[17] Ibid.

[18] Ibid.

供应人体营养
促进人民健康
增加禽畜生产
促进农业兴旺

Photo credit: Alan T. Crane

With the new economic liberalization have come new marketing techniques including western style billboards.

Technology transfer will be an important factor shaping these conditions in which Chinese economic and political institutions evolve. However, it should not be assumed that the "imperatives of technology" will be determinative of institutions. The weight of evidence from Chinese experience and the experiences of other countries suggests otherwise.[19] Instead, the imperatives of technology should be seen as *inclining* institutional choices in certain directions, not all of which will be the same.

Technology transfer affects the evolution of Chinese institutions in two ways: what the Chinese will have to do if technology transfer *is to be effective*, and the consequences for institutions if technology transfer *is effective*. In both cases, the impacts are likely to appear contradictory.

To be effective, technology transfer would seem to require the further marketization of the economy, including more fully developed labor and capital markets, a price system that provides microeconomic decisionmakers with accurate economic information, and a further clarification of property rights. The persistence of an irrational economic environment (including irrational prices and irrational limitations on the efficient movement of capital and labor) appears to affect adversely China's ability to select technology wisely and assimilate it fully.

At the same time, there are certain negative externalities associated with market transactions in technology that seemingly require strong administrative responses from the central authorities. These include the problems, discussed in chapter 3, of the duplication of technology imports and of importing technology that may already be available in China. Central controls over the expenditure of foreign exchange for technology are also appropriate in light of the collective disadvantages that result from an uncoordinated use of this scarce resource.

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[19] See Richard P. Suttmeier, "Science, Technology and China's Political Future: A Framework for Analysis," paper presented to the Conference on China's New Technological Revolution, Harvard University, May 1986.

Other types of problems associated with negative externalities can also be noted. These would include the setting of technical standards for imported technology and the establishment of health and safety standards. In short, an effective technology transfer program will require not only more decentralized marketization, but also more vigorous policy interventions from a stronger central government, seemingly a contradiction.

Similarly, successful technology transfer is likely to be both a force for greater decentralization of Chinese society and a force for more effective centralization. Decentralizing trends will result because successful technology transfer will make enterprises and other economic units more autonomous vis-à-vis central authorities and less dependent on them. Successful technology transfer will entail networks of relationships between economic units and foreign suppliers of technology, which will be very difficult for central authorities to control. Often, the technologies transferred will be empowering of lower level organizations, and they will often require new forms of specialization that should be a force for greater economic and social pluralism.

At the same time, successful technology transfer will strengthen the capabilities of central authorities. Especially in areas such as transportation, telecommunications, and data processing, foreign technology should help the state penetrate and control society more effectively. The society it will want to control, however, will itself be more empowered and thus be in a better position to resist the penetration of the center. Whether these developments are constructive and progressive, or debilitating, depends on many nontechnological factors that are not likely to be determined in the first instance by technology transfer.

On balance, technology transfer should be a constructive force in China's future. It is likely to make possible rapid improvements in the quality of China's export goods, to become an increasingly important factor in Chinese economic growth, and to be an important factor in overcoming major constraints on growth and development caused by underdeveloped infrastructure and energy supplies.

The impacts on the evolution of Chinese political and economic institutions are likely also to be salutary, although there is much more uncertainty connected to this prediction. As seen in chapter 3, China needs both more decentralization *and* more effective centralization, and technology transfer is likely to be a force for both. The great uncertainty is whether the nature of the current system, with its many economic and political irrationalities, will have more of an impact on technology transfer than vice versa.

IMPLICATIONS FOR THE UNITED STATES AND THE WORLD ECONOMY

It has been U.S. policy since the 1970s that a friendly modernizing China is in the U.S. interest. Quite apart from any foreign involvement, China is undergoing major changes designed to realize finally a century-long quest for wealth and power. The United States and other countries are now involved in these changes in China, and technology transfer is one of the prominent modes of involvement. The implications of this involvement must be understood in order to judge whether it serves U.S. interests.

One area where the implications of China's future course require rethinking is China's international economic role. China's foreign trade has expanded dramatically in recent years, albeit from a small base, and China clearly has premised its current modernization drive on active participation in the world economy. China's interest in membership in the General Agreement on Tariffs and Trade is indicative of its growing interest in and commitment to international economic institutions.

China's export economy suffers from both technical and systemic inefficiencies. The economic system reforms, currency revaluation, and other incentives for Chinese producers to export rather than sell to the domestic market will help alleviate systemic inefficiencies. Technology transfer will help with the technical inefficiencies. Indeed, the main short-term consequence for economic performance of technology transfer will be to improve the performance of the export sector, mainly through qualitative improvements.

China's foreign trade potential is much greater than its actual trade today. The rate of growth of China's foreign trade has been greater than the overall rate of economic growth, and this is likely to continue for the next 15 years. China's exports have been rising at an average annual rate of 14 percent since 1978, and the value of exports now represents 7 percent of the gross national product. It is quite possible that by 2000, this latter figure could be doubled.

If current trends continue, Chinese exports will represent about 4.4 percent of world exports by 2000. This percentage is comparable to the current shares of such countries as Italy and Canada. China's considerable ability in recent years to capture market shares has been due largely to its low prices, which are due in turn to its low production costs. The growth of Chinese exports, and China's penetration of foreign markets, has occurred during a deflationary period in international trade. This fact also suggests that the potential for growth of trade has not yet been fully demonstrated.

As China's exports have increasingly diversified, questions have arisen about whose products China's will replace in which markets. During the next 15 years, Chinese products are most likely to be competing with those of the NICs (including Singapore, Malaysia, Brazil, India, Mexico, Thailand, Argentina, Hong Kong, Taiwan, and Korea) in third country markets. Direct competition with either the LDCs or developed countries such as the U.S. is less likely. One exception to this is that U.S. agricultural exports to Asian markets may suffer from Chinese export expansion.

China's imports are heavily weighted toward industrial supplies and producer goods rather than consumer goods and should offer attactive trade prospects for the United States. In light of the above, and although Chinese exports will compete with some U.S. products of older industries in U.S. markets,[20] it should be in the U.S. interest to see the expansion of Chinese exports. However, the U.S. share of the Chinese market has fallen, due in part to more aggressive marketing and more efficient export control practices in other countries.

Other problems also make the actual prospects for Chinese exports less rosy than the potential suggests. China's interest in a more active participation in world trade does not come at the best of times. Many of the markets in the advanced industrialized countries are already vulnerable to pressures from imports, and protectionist sentiments in places run high. In addition, the cost advantages Chinese products enjoy because of cheap labor may not be enduring. New technological advances in the advanced countries in industries that were vulnerable to inexpensive imports based on low wage rates could upset established patterns of comparative advantage in the near future.

China's rapid decline of foreign exchange holdings has led to increasing interest in commercial credits. The Seventh Five-Year Plan expects $40 billion to $50 billion in financing of all kinds from abroad. As with foreign exchange, there has been some loss of central control over international indebtedness because of the increasing financial role of organizations such as the China International Trust & Investment Corp. (CITIC). According to estimates made by the Bank of Japan, China's foreign debt by the end of the Seventh Five-Year Plan in 1990 could reach $49 billion.[31]

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[20] A politically significant example is textiles.

There is no consensus about the longevity and severity of these problems. They have made the Chinese more insistent that in its trading relations, ways must be found to increase China's exports. They are also likely to lead China to seek more barter opportunities, which could lead to more trade with the Soviet bloc. Such trade would reduce the pressure on the use of hard currency reserves, would be more insulated from the perturbations of the international capitalist economy (e.g., the fall in oil prices), and would be more congenial to the operation of the centrally controlled, planned sector of the economy.[32]

China's problems of adjusting to the international economy are also likely to limit the growth of U.S.-China trade and economic cooperation in the short run, particularly when the problems of foreign investment are also considered. Efforts to improve the investment climate are not likely to have rapid results. The appeal of joint ventures has faded for the moment, which is likely to slow technology transfer and change the mode of technology transfer preferred by U.S. companies to licensing agreements.

China continues to give evidence of wanting to participate in the world economy and to reap the benefits of foreign investment and technology transfer. To do so, China must export. It is likely that a number of bilateral and multilateral trade issues will result from Chinese export expansion. These include the persistence in Chinese efforts to realize bilateral trade balances, a likely increase in Chinese use of export subsidies and other forms of protectionism in China, the lack of transparency in Chinese trade decisions, and the changeableness and unpredictability of those decisions. The rise of protectionism on the U.S. side, already evident in the growth of antidumping cases brought against Chinese imports, further complicates the prospects for U.S.-China trade and for U.S. participation through technology transfer in Chinese modernization programs.

IMPLICATIONS OF A FAILED MODERNIZATION PROGRAM

All developing countries are faced with very tight constraints imposed by population pressures, environmental limitations, and pressures from the international economy. The tightness of these constraints often puts enormous pressures on social institutions, making governance and the maintenace of domestic stability difficult.

China is no exception to this observation. Indeed, many of its constraints are particularly severe. China's leaders continue to be in a contest against demography and environmental degradation, and they must race to keep from falling further behind the economic and technological progress of other countries.

This chapter has suggested that the international community as a whole will benefit from China's modernization, though problems will emerge in certain areas. However, successful modernization is not guaranteed. The direct implications for the world economy if China's modernization fails to meet expectations are fairly easy to predict: China will be less of a market and less of a producer. The domestic implications are considerably more complicated because the stakes are very high, both for China's leaders and for the Chinese population.

There is a distinction between a "failed modernization program" and a "failure to modernize." China is already "modernizing" in the sense that China has been experiencing a series of societal changes. Examples are industrialization and the substitution of inanimate for animate energy, urbanization, increased literacy and life expectancy, the development of a science and technology base, establishment of and penetration of society by mass media. China's modernization program, The Four Modernizations, is a conscious effort to give Chinese societal change new quantitative and qualitative dimensions that will enhance national wealth and power and individual well-being.

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[31] *Mainichi Daily* News, Sept. 6, 1986, p. 6.

[32] Yuan-li Wu, "Economic Reform and Foreign Economic Relations: Systemic Conflicts in a Theoretical Framework," paper presented at the Fifteenth Sino-American Conference on Mainland China, Taipei, June 1986.

The partial modernization experienced by China (albeit, unevenly distributed across China) has created expectations in the population that more will follow and that living standards and quality of life should improve. The increasing exposure experienced by many Chinese to the lifestyles of Hong Kong, Taiwan, Japan, and the West fuel these expectations further. One of the requirements of a successful modernization program is to be able to respond to these expectations. Fulfilling that requirement is a challenge to the political system.

At the same time, the modernization that China has experienced has brought with it a series of new challenges to the capabilities of the state. China's problems of energy supply, urban transportation, sewerage, telecommunications, and housing are all more serious precisely because modernizing change has begun. These problems are likely to remain unsolved and to worsen if the modernization program is not successful.

The problems associated with population growth and employment during the next 15 years (and beyond) will be particularly difficult. Between 1981 and 2000, the Chinese working-age population will increase by about 250 million, with a probable increase in the labor force of 180 million. To provide employment for these new entrants into the labor force would require an average annual increase of new jobs of 10 million.[23]

Photo credit: Richard E. Gillespie

Assembly of surge arresters under GE license at the XD Porcelain Insulator Factory.

Also affecting the employment picture will be the significant shift out of agriculture and other forms of rural employment to urban jobs. Whereas 36 percent of the work force now lives and works in cities and towns, this figure is expected to rise to 54 percent by 2000. The need for rural workers will decline.[24] China, in short, will be much more of an urban society by 2000 than it has been.

The smaller cities and towns will feel the most demands from the new job-seekers. Their capacity to respond to these demands remains unknown, but the scale of the problem will be large. As one analyst has put it:

> Coping with the waves of peasants who flock to urban areas looking for work will pose extraordinary challenges to the social and economic infrastructure of China's small cities and towns. Not only will jobs for these people be required; they will need housing, access to medical care, transportation, schools, stores and a host of other services taken for granted.[25]

China's ability to cope with the social disruptions of modernizing change will be enhanced by a growing economy and improvements in China's political and administrative institutions. The state will clearly need additional resources—for investments in human capital, social services, infrastructure, and the like—to smooth the transition to modernity. A growing economy will make the task of extracting these resources easier, as will political and administrative institutions capable of fair and efficient extractions and the implementation policies that will cushion the effects of rapid social change.

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[23] The World Bank, *China: Long-Term Issues and Options* (Washington, DC: 1985), p. 185.

[24] Jeffrey R. Taylor, *Employment Outlook for China to the Year 2000*, CIR Staff Paper No. 16 (Washington, DC: Center for International Research, U.S. Bureau of the Census, March 1986), p. 2.

[25] Ibid., p. 17.

A China not able to meet these requirements is likely to be a China overflowing with individual and collective frustrations. For the individual, long-suppressed aspirations for a better quality of life, were in the post-Mao period, would be frustrated again. For the society as a whole, a failure to fulfill the the promises of the Dengist leadership for developing the nation's human and natural potential and thereby instilling national pride, would be a disappointment of massive proportions. A society with such frustrations would be a society susceptible to the appeals of political extremism and to the dangers of political instability.

Domestic political extremism and political instability in China can have international implications. A politically unstable China, or one under the sway of an extremist leader, is more likely than present-day China to be a disruptive force for the regions around its periphery—especially on the Korean peninsula and in Southeast Asia. Such a China is also likely to be more difficult to deal with on the Taiwan problem and on the future of Hong Kong. A more extremist China is likely to support Third World insurgencies and to be a more disruptive force in international fora, such as the United Nations. In short, a China subject to the influences of political extremism as a result of a failed modernization program is likely to be a considerably less constructive member of the international community than the present China.

A modernizing China must live with constant risks of instability. Without technology transfer, however, China's modernization program will be much more difficult to implement, and a failed modernization program threatens to leave China with troubling national frustrations, to undercut the legitimacy of the reformist coalition, and to expose China to the appeals of more radical political doctrines. Such a China would have less of a stake in a stable international order than does a China pursuing its current course.

Chapter 7

Strategic Implications of a Modernizing China

Photo credit: Eric Basques

The Great Wall at Ba Da Ling Pass, about 40 miles north of Beijing. For centuries, the wall was the main line of defense against northern invaders.

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Chapter 7

Strategic Implications of a Modernizing China

A more modernized China will also be a stronger China, one that will have enhanced capabilities to pursue its interests in the international arena. A central question for the United States, then, is whether a stronger China would be in the U.S. interest. Since technology transfer aids Chinese modernization, thus strengthening China, are today's transfers likely to become tomorrow's sources of regret? Are U.S. strategic interests, especially in Asia, likely to be served by a stronger China whose modernization has been aided by the transfer of U.S. and other Western technologies?

The "China factor" in U.S. strategic interests depends on:

1. Chinese military capabilities,
2. Chinese plans and expectations for military modernization in the context of overall economic development goals, and
3. the role of technology transfer in Chinese military modernization.

It is also important to consider prospects for the evolution of China's foreign policy and the possible implications for U.S. strategic interests in Asia.

TECHNOLOGY TRANSFER AND CHINA'S MILITARY CAPABILITIES

Military Capabilities

Although the development of a modern defense remains an important objective (military modernization has been officially ranked fourth on China's list of modernizations), defense spending occupies a much smaller share of the gross national product (GNP) than a decade ago.[1] China's slow road to military modernization does not overshadow its current strategy of introducing systematic wide-sweeping economic changes that will, over the longer term, improve military capabilities. Transfers of dual-use technology are important to that process.

No official plan for defense modernization has been announced, but it appears that the Chinese are attempting to improve combat effectiveness in the short term while building a technology and defense industrial base capable of indigenously developing and producing advanced weapons over the long term. Limitations in financing and skilled manpower plus the inability of the defense industries to mass produce advanced weaponry have dictated this strategy. As one expert observer puts it: ". . . Even if it were possible, the defense establishment would have been overwhelmed by any rapid introduction of advanced technology. No 'quick fix' was plausible, even if it were seen as desirable."[2] The deficiencies of currently deployed People's Liberation Army (PLA) hardware are worth noting.

China's conventional weapons are based on technology supplied by the Soviet Union in the 1950s. China received military equipment and know-how, but when the Soviets terminated their assistance in 1960, China lacked a group of trained engineers and professionals capable of designing a new generation of weapons.

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[1] China has, however, expanded funding for one part of its defense budget—strategic forces. See Ed Parris, "Chinese Defense Expenditures, 1967-83," in The Joint Economic Committee (JEC), *China's Economy Looks Toward the Year 2000*, vol. 2, 1985, pp. 148-168.

[2] Paul H.B. Godwin, "Overview: China's Defense Modernization," in JEC, op. cit., vol. 2, p. 138.

China's military industries remain unable to design new systems or serially produce from foreign designs.[3] China's military weaknesses in communications, logistics, and basic operations were apparent in its 1979 punitive expedition in Vietnam.[4]

At present, China does not have the power projection capabilities needed to sustain a successful offensive attack on neighboring countries, and its forces are far inferior to those of either of the superpowers.

China's air force is dependent on obsolete interceptors and bombers that could not survive long against modern air defenses. China's air force includes more than 4000 fighters, but these are modifications of foreign designs, primarily the Soviet MiG-19 and MiG-21. Much of the fleet lacks all- weather capability and night vision; speeds are generally subsonic. Most of the fighters are armed with cannons only. China's aircraft factories lack the technology and metallurgy needed to design and manufacture sophisticated, high-yield jet engines.

The Chinese navy has only a few dozen destroyers and frigates, many armed with STYX missiles that have a short range and radio-controlled guidance systems, making them vulnerable to enemy jamming. China's more than 100 submarines are deployed in shallow coastal waters. Many of the craft are diesel powered, noisy, and limited in range. Lacking electronic countermeasures and support systems, they could easily be defeated by Soviet antisubmarine warfare devices.

China's first of at least three nuclear-powered attack submarines, the Han-class, was launched in the early 1970s. In addition, a Xia-class missile submarine (comparable in size to the British *Polaris* but developed largely indigenously) was launched in 1981. It has antiquated sonars and guidance systems as well as problems with the nuclear plant that appear to have kept it in the shakedown phase. Production is likely to remain low.[5] In 1982 a flight test of a submarine-launched ballistic missile (from a diesel submarine) took place.[6] While China's nuclear fleet is likely to remain quite limited because of financial constraints, the flight test indicates that China will probably significantly increase its nuclear deterrent force through the deployment of a seaborne, strategic, second-strike capability.

The size of the PLA has been reduced by over 1 million during the past 6 years, but China still maintains the world's largest military in terms of personnel.[7] Nevertheless infantry mobility is a major problem. Although the PLA has more tanks and armored personnel carriers than the U.S. army, the ratio of personnel to armed vehicles is approximately 10 times higher than that in the Soviet army. PLA field guns, rocket launchers, and heavy mortars are all obsolete. Antitank guns and recoilless rifles have short ranges. A major effort is now under way to streamline the PLA and to transform its role by improvements in training and by encouraging military factories to produce for the civilian market.[8]

Because China would find it difficult today to retaliate against a surprise attack by the Soviet Union, high priority has been placed on building strategic forces. Significantly, this effort has been continued even during times of drastic political change. China's more than 100 medium- and intermediate-range nuclear missiles constitute a modest arsenal by superpower standards, but they provide China with enhanced political prestige and with some capability to deter a Soviet attack.[9] Little information is available about performance or accuracy, but it is generally agreed that China's intercontinental ballistic missiles (ICBMs) are liquid fueled, requiring a long lead time for launch preparation. Today, China has only a handful of ICBMs capable of reaching the United States. Nevertheless, its strategic program is a "pocket of excellence" in its defense sector, one that testifies to the maxim that significant developments are possible when a program is given high priority.

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[3] Wendy Frieman, "National Security Risks of Dual-Use Transfers to China," Science Applications International Corp., July 7, 1986 (app. 6 in vol. II of this report).

[4] Paul H.B. Godwin, "Overview: China's Defense Modernization," in JEC, op. cit., vol. 2, p. 137.

[5] Frieman, op. cit., p. 29. One Xia is now in operation and a second is said to be near completion.

[6] David G. Muller, Jr., *China as a Maritime Power* (Boulder, CO: Westview Press, 1983), p. 165.

[7] See June Teufel Dreyer, "The Reorganization and Streamlining of the Chinese People's Liberation Army," for 15th Conference on Mainland China, June 8-14, 1986. The International Institute for Strategic Studies (IISS) in London estimates that the total size of the PLA was 3.9 million in 1985-86, of which about 2.9 million were in the army. See IISS, *The Military Balance*, 1985-86, p. 113.

[8] Opinions differ sharply as to whether the PLA will be plagued by resistance to such programs or whether it can be a "vanguard" in the modernization process. See Dreyer, op.cit.; and Monte R. Bullard and Edward C. O'Dowd, "Defining the Role of the PLA in the Post-Mao Era," *Asian Survey*, June 1986.

[9] Robert G. Sutter, "Chinese Nuclear Weapons and American Interest—Conflicting Policy Choices," in JEC, op. cit., vol. 2, p. 170.

At the same time, it should be noted that PLA equipment has proven adequate for most important military functions undertaken since 1949. China does not need the most technologically advanced systems in all areas to maintain a position as a regional power. China's defense expenditures are, moreover, of significant value,[10] and its extensive defense industrial base has produced large amounts of conventional arms. These weapons, while unsophisticated when compared with those of the two superpowers, are selling well on the international market, particularly to developing countries.[11] China's reported arms sales to both Iran and Iraq suggest that its arms export policies may be a significant factor in some Third World conflicts. China may also extend its influence in space-related activities, as indicated by its offers to launch foreign satellites.

Military Strategy

China's overall military strategy remains a subject of debate in the West, but deterring a Soviet invasion remains the top priority. Chinese military planners also intend to improve their ability to conduct military operations on their borders and to ensure coastal defense.

Photo credit: Xinhua News Agency

The Long March 2 rocket at the Jiuquan (northwest China) launching site. This two-stage, liquid fuel rocket first flew successfully in November 1975 and is used to place payloads in low-Earth orbit. Sweden's Mailstar may be launched by a Long March 2.

Threat assessments appear less pessimistic than they were before the death of Mao. A new strategy called "People's War Under Modern Conditions" features less emphasis on mobile and more on positional warfare, less on luring deep and more on developing capabilities to counter a front-line offensive threat.[12] China seeks not only to deter Soviet aggression, but also to develop a reliable strategic retaliatory capability in case deterrence breaks down.[13] A costly "people's war" of attrition would be used today only as a last resort. Instead, China seeks to develop the conventional and nuclear capability to defeat an invader. While the future shape of China's strategic forces is an unknown, gradual modernization of existing forces is expected. A quick strategic buildup could alarm both superpowers. Uncertainty remains in the West, however, about the speed and type of military modernization planned for China's strategic forces.

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[10] RIPS, *Asian Security 1985*, pp. 77-78; China's defense budget is now exceeded by that of Japan.

[11] Estimates of the value of China's arms sales vary. See Claire Hollingsworth, "Your Friendly Chinese Arms Merchant," *Wall Street Journal*, June 17, 1985 for an estimate of $1.6 billion in Chinese arms sales in 1984 alone. See also Anne Gilks and Gerald Segal, *China and the Arms Trade* (New York: St. Martin's Press, 1985). According to one estimate, China became the fourth largest arms exporter in 1986. See Michael R. Gordon, "War in Gulf Spurs China's Arms Export Role," *The Washington Post*, May 19, 1987.

[12] See June Teufel Dreyer, "The Streamlining and Reorganization of the Chinese People's Liberation Army," paper prepared by International Studies Association, March 1986, p. 8.

[13] Sutter, op. cit., p. 179.

Technology Transfers

Given China's broad range of modernization goals and its limited financial and skilled manpower resources to assimilate technology, it is not surprising that military imports have been limited during the past decade. Western observers have been unable to identify an overarching theme that guides China's acquisition of foreign weapons systems.[14] China's few military acquisitions in the past decade have spanned the gamut of mission areas, as indicated in table 2 of appendix 6, volume II.

Despite this apparently unsystematic approach to foreign weapons acquisition, significant incremental changes can be discerned. The T-69 tank, an upgrade of the T-59, includes a foreign-made, infrared searchlight and laser range finder. Electronic improvements in the F-8 will also result in incremental changes if implemented as planned. Generally speaking, importation of foreign military technology has been geared toward marginal improvements in already existing Chinese military systems. Purchases have often been small, representing in many cases "samples" for study.[15]

Prospects for expanded procurements of foreign military weapons have undoubtedly improved in recent years. However, China will probably continue to find it too expensive to import weapons on a large scale. Nor does it seem likely that China would readily turn to foreign suppliers for complete weapon systems. China's limited importation of military technology is guided by the goal of improving indigenous design and production capabilities over the long term. See chapter 8 for a discussion of U.S. military sales to China.

In contrast to purely military sales, dual-use technology transfers have expanded markedly during recent years.[16] Theoretically, such dual-use exports could contribute to military modernization. A powerful computer, for example, could be used to improve the efficiency of a military or a civilian production facility. How have these transfers affected China's military capability?

During 1985, U.S. exports of computers and office machines to China were valued at more than $187 million.[17] Table 8 in chapter 4 provides an overview of the expanding values of licenses granted for exports to China during recent years. Electronic machinery imports, particularly computers and integrated circuit manufacturing technology, have been a particularly prominent growth area as shown in the licensing data. Imports of dual-use technologies came from a wide array of supplier countries, and a number of Chinese organizations were involved.

Most dual-use imports are imported by civilian end-users in China, but it would be a mistake to assume that the military could not acquire them. On the other hand, it is not clear that military factories would necessarily be able to assimilate and use such imports successfully. Nor does the range of imports suggest a strategy designed to target dual-use imports to a few key military operations.

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[14] One explanation for this lack of coherent strategy is that some parts of the Chinese bureaucracy appear more eager to import foreign weapons than others. There is a natural divergence in perspective between the Chinese factories producing antiquated hardware and the end users attracted to technologically advanced foreign products. There is also a sharp divergence between the strategic programs, where importation is virtually precluded, and China's conventional force needs.

[15] International Institute for Strategic Studies, *The Military Balance 1986-87* (London: 1986), p. 140.

[16] "Dual-use technology" has both military and civilian applications. Much advanced technology today falls into this category. The United States controls exports of such technology through required review of export licenses, as outlined in the CCL. For purposes of this study, dual-use technologies of particular concern are included in the technologies and products that today require interagency and COCOM review for export to China. As discussed in ch. 8, U.S. policies have shifted during the past 7 years to loosen restrictions on exports to China, but many high-technology products still require such reviews.

[17] U.S. Department of Commerce trade data. During the same year, the U.S. Government issued licenses for $3.8 billion in computer exports to China. Clearly, in many instances final shipment never occurred. This discrepancy is analyzed in ch. 8.

The question of military access to dual-use technology hinges centrally on the degree of overlap between civilian and military production. All of China's six major ministries involved in weapons-related production are also responsible for producing civilian products. The Ministry of Aviation and the China State Shipbuilding Corp. build planes and ships, for example, for both civilian and military uses. As in the United States, many defense factories are managed by civilians. Similarly, China's premier research establishment, the Chinese Academy of Sciences, has been strongly involved in the strategic program and in avionics and aircraft research and development.

Although military factories do have some advantages[18] over civilian factories (e.g., in their priority for acquiring resources), there is no evidence that they have superior capability across the board. Even if China's military can obtain foreign advanced technology, history suggests that it will not be an easy task to assimilate it. This is illustrated by the case of dual-use transfer to the military involving the Spey jet engine. Despite the fact that it was a landmark project, the factory never began serial production. A number of factors undoubtedly contributed to this situation, but the result was that the Chinese did not fully assimilate the Spey technology so that they never began manufacture.

Moreover, examples of successful reverse-engineering by the military are few. China's production system is plagued by systemic problems that limit productivity and reduce the potential effects of technology transfer domestically. China faces a number of obstacles to the full assimilation of foreign technology in areas important for military production: China does not have adequate semiconductor materials technology, precision testing equipment, and the clean-room facilities required for mass production of integrated circuits. (The circuits are vital to the manufacture of sophisticated electronic systems necessary to upgrade PLA command, control, and communications.) Nor does China have the capacity to produce the metal alloys required for advanced airframe construction. Although China is richly endowed with metals such as nickel, titanium, molybdenum, magnesium, and cobalt, China's factories have been unable to ensure the requirements for processing high-purity metals.

Regardless of whether or not the military factories will effectively make the transition to civilian production, the effect of current reforms (if implemented) will be to blur further the distinction between civilian and military production. This will make it even more difficult for foreign suppliers to set constraints that limit use of their technology by the military.

Military needs are probably factored into the purchases of foreign technology and equipment by the machine-building industries, though not through any monolithic targeting strategy like the one developed by the Soviet Union to obtain advanced Western technology.[19] The National Defense Science, Technology, and Industry Commission (NDSTIC), however, reviews requests for foreign technology above certain dollar amounts to determine priorities and whether Chinese-made equipment could be substitued, thus ensuring that military requirements are at least taken into account in major foreign technology acquisitions.[20] The China Defense Science and Technology Information Center was set up a decade ago to monitor foreign technology developments for the military.

The conclusion that follows from this analysis is that the military could in principle obtain dual-use technologies, but would not necessarily be in a better position than a purely civilian factory to assimilate them. Nor is there evidence that past dual-use transfers have led to significant improvements in China's military capability.[21]

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[18] See, for example, K.C. Yeh, *Industrial Innovation in China With Special Reference to the Metallurgical Industry* (RAND Note), May 1985. Yeh notes that by the early 1980s the ratio of scientific and technical manpower to total employment in the defense industries was three times that for the country as a whole.

[19] See U.S. Department of Defense, *Soviet Acquisition of Militarily Significant Western Technology: An Update*, September 1985, for a description of the Soviet targeting effort.

[20] See Frieman for a discussion of the role of the NDSTIC and its interaction with various ministries, pp. 10-19.

On the other hand, the cumulative impact of dual-use transfers will probably be noticeable in China's military production by the year 2000. While the most significant and dramatic improvements in China's military capability may occur through military imports, dual-use transfers will permit gradual overall improvements in production capability. More specifically, raising the technical skills of the workforce, upgrading numerical and quality control, and improved management and manufacturing techniques should eventually lead to better production in military as well as civilian factories.

Over the short term, China faces such a wide array of shortcomings in its military that most imports of sophisticated dual-use technologies are likely to result in improvements only on the margin. Unlike the Soviet Union, where a single dual-use technology may fill a critical hole in a modern military system, China's more extensive needs cannot be effectively addressed in this way. In China, however, incremental progress across the board may well be coupled with substantial improvements in key areas such as launch capabilities for strategic weapons. These developments will surely heighten China's role, particularly as a regional power in Asia, during the 20th century.

Looking ahead to the year 2000, many dual-use transfers carried out over the 20 years previous can be expected to contribute to an overall upgrading of China's military capability. China cannot emerge as a military superpower on par with the United States or the Soviet Union by 2000, but if it succeeds in its overall economic modernization program, it will be poised to make significant leaps in overall military capability thereafter. Even before that time, improvements in key areas of military operations or in logistics and transportation may occur that will improve China's ability to defend itself or launch attacks against neighboring countries. Because the United States and the Soviet Union will continue to improve their own military capabilities, however, China stands little chance of catching up with either of the superpowers over the next 30 years.

U.S. Policy Considerations

U.S. policies concerning transfer of dual-use and military technologies are based on assessments of myriad factors, among them, potential risks or benefits to U.S. national security. Current policies reflect an evaluation that transfers of most dual-use technologies are unlikely to affect China's overall military capability significantly in the near term. Therefore, with improvements in bilateral relations has come a loosening of U.S. export restrictions. As discussed more fully in the next chapter, controls are maintained on the most sensitive technology exports.

Military transfers (to date, few in number) are guided by the principle that military cooperation is a natural part of the bilateral relationship and that improvements in Chinese air defense and antiarmor capabilities can help deter the Soviets without threatening China's non-Communist neighbors. U.S. policy on munitions restricts exports that would improve China's capabilities in key mission areas: nuclear weapons design, antisubmarine warfare, electronic warfare, intelligence gathering, and the projection of power (Table 15 lists the technologies involved in the anti-submarine warfare mission area.)

The limited scope of U.S.-China military cooperation is illustrated by the scope of government-to-government sales through the Foreign Military Sales program.[22] Despite a host of official visits of defense-related officials from both countries, many observers believe that military cooperation will proceed slowly in the near term.[23] The trend so far has thus been for

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[21] See ch. 8 for discussion of dual-use sales to China's military

[22] The Foreign Military Sales program has been permitted to make sales to China since 1984, but few have yet occurred.

[23] Kerry B. Dumbaugh and Richard G. Grimmett, *U.S. Arms Sales to China*, Congressional Research Service Report No. 138-F, 1985.

Table 15.—Anti-Submarine Warfare Technology

Anti-submarine warfare (ASW) consists of those warfare elements that result in the detection, identification, and destruction or disabling of an enemy submarine. ASW can be conducted from any suitable "platform" from the air, sea surface, or from another submarine. The basic **functions** needed to successfully conduct the ASW mission are the same for each platform and are described below.

Functions:

1. **Detection** of the enemy submarine by either acoustic or nonacoustic methods.
2. **Classification** determination of the type of target.
3. **Localization** target motion analysis and contact management.
4. **Approach to the Target** closing in on the submarine to within range of one's own ship or aircraft weapons.
5. **Weapon Deployment (Launch)** the actual attack.
6. **Evasion and Reattack** activities performed if necessary.
7. **Related Functions** tactics such as mine avoidance, mine deployment, and surveillance that are performed as necessary.

Although the basic required ASW functions listed above are always the same, the complexity and difficulty of each of these elements varies from case to case and from platform to platform.

Technologies:

The **technologies** required to accomplish the above functions effectively span a large range of engineering and scientific disciplines. They can be categorized as follows:

1. *Mechanical Engineering*: propulsor design, low-noise machinery, low-speed turbines, bearing design, and quiet weapon launch design.
2. *Hydrodynamics*: hull design (for speed), boundary layer control theory, and pipe-flow design.
3. *Materials Engineering*: corrosion-resistance technology, ceramic design, elastomer technology, lightweight structure development, composite materials, and sensor technology.
4. *Acoustic Engineering*: sonar dome/outer decoupler design, transducer design, baffle design, machinery sound isolation, quiet weapon launch design/propulsion, acoustic miniaturization, and damping material design.
5. *Sonar Design*: algorithmic development for classification techniques, acoustic correlation techniques, tracker design, contact motion analysis techniques, beamforming techniques, spectrum analysis, adaptive noise cancellation, transient analysis, automated detection techniques, automated classification techniques, automated trackers, and adaptive processing.

   Additional technologies involved in sonar design are passive ranging techniques, multipath processing techniques, weapon guidance techniques, acoustic performance prediction techniques, environmental sampling techniques, active sonar processing techniques, low probability of intercept concepts, and satellite environmental observation.
6. *Power Engineering*: high-density, power-pack design; small-size, high-power train design; and high-impulse/exotic fuel design.
7. *Computer Design*: bus/local area network design, spectrum analyzer design, microelectronic design, beamforming design, high-speed mathematic processor design, minicomputer design, and transient processor design.
8. *Graphic Engineering*: high-speed graphic techniques, color/bit plane graphics, large-field graphic design, and man-machine techniques.
9. *Warhead Engineering*: shaped-charge techniques, fusing design, and high-explosive technology.
10. *Electrical Engineering*: power engineering, pulse-forming design, and high power/rapid transient design.
11. *Nonacoustic Engineering*: magnetic anomaly detection technologies.

It is clear that there is no one ASW technology; capabilities are required across a broad spectrum of engineering and science. Some technologies are critical in the sense that if their performance is substandard, the whole ASW system is significantly affected. It is necessary to conduct each stage of an ASW attack adequately to be successful. On the other hand, there are degrees of successful implementation of each stage. Each increased level of sophistication will have a higher level of success in ASW, but there are many different levels that can be successful.

SOURCE: Adapted from "Assessment of ASW Technology Transfer to the People's Republic of China," contractor report prepared for OTA by Global Associates, Ltd., Alexandria, VA, Dec. 17, 1986.

rapidly expanding sales of dual-use technologies, coupled with increasingly frequent military visits and infrequent military sales (e.g., the avionics package for the F-8).

If controls are further relaxed, the key question from a national security perspective is: Which technologies currently restricted could make a significant difference in China's military capability if transfers were permitted? If China were to import greatly advanced radars and electronic countermeasures (above those needed for air defense), the ability of the air force to mount offensive attacks against neighbor states would be strengthened. The navy's capabilities could be upgraded through improved propulsion systems, electronic surveillance systems, and air cover. Improvements in ground force equipment, however, would remain of limited value in engagements along the borders unless more effective air cover and naval support were available. China's ability to project force thus depends on improvements in those areas in particular.

Possibly the most significant changes in Chinese military capability would accompany transfers of technologies that improved its strategic nuclear deterrent. For instance, technologies that improve China's missile targeting and real-time imaging from satellites could signficantly affect China's military capability.

These judgments are based on a general assessment of China's military requirements. In practice, export administrators make decisions about the risks of transferring dual-use technologies on a case-by-case basis. In each case, it is necessary to ask how the transfer could affect China's military capabilities.

For example, anti-submarine warfare (ASW) is one of the key mission areas mentioned above. Until such time as a political decision is made that enhancing China's ASW capability will not compromise U.S. national security, technologies that would contribute to ASW must be controlled. However, many different technologies are involved in ASW, as described in tables 15 and 16, and a large fraction are also used for commercial purposes. Those technologies useful only for ASW are obviously candidates for strong control (essentially, red zone), whereas it would serve no purpose to control those that are not critical or are readily available commercially. The difficult decisions involve technologies that are critical but available to some extent (group b in table 16).

An additional complication arises because few technologies come in one form only. There is generally a range of sophistication available. In most cases, military systems incorporating the latest, most sophisticated versions of technology have the greatest capabilities. More limited versions of the same technology may be of little concern (e.g., ASW systems that can detect noisy submarines but not American subs which are very quiet). This factor requires criteria to be set based on critical characteristics of the technology (e.g., speed of operation). Below a certain level, a particular export license application for equipment or technology is considered to be in the green zone because it could not contribute to a military system that would be of concern. Applications involving equipment or technology above that level are reviewed on a case-by-case basis and referred to other agencies. A key policy decision is under what conditions should these applications be approved. Another is where to draw the cutoff line for technologies that wili not be exported under any conditions.

These points are illustrated by the handling of spectrum analyzers, one of the critical, dual-use technologies for ASW, described in box B. Hewlett-Packard is a major manufacturer and exporter of spectrum analyzers. It offers three real-time models of the type appropriate for ASW use. Model 3561A requires about 170 milliseconds (ms) to calculate 512 lines, well within the green zone. However, recent export applications have been handled by the Department of Commerce (DOC) as above the green zone. Model 3562A is much faster at 2048 lines in 50 ms. Model 3565S is a multichannel system with a computational rate that varies depending on configuration. Its status is unclear. None of these models would be used as the prime technology in a U.S. ASW system, but 3562A is considered quite fast. Similar, though probably not quite as sophisticated, equipment is made in other countries, including Germany and Japan.

If the green zone were enlarged, applications which now have to be referred to the U.S. Department of Defense (DoD) and to the Coordinating Committee on Multilateral Export Controls (COCOM) might be eligible for expedited licensing. One approach would be to include models faster than the present speed of 512 lines in 50 ms. Models 3561 and 3565 (under most configurations) could be placed well in the green zone with lttle ambiguity. The National Council for U.S.-China Trade has proposed an alternative change for Commodity Control List 1529 that would make all spectrum analyzers green zone if they have a real-time rate of 10 kHz or less. This criterion would

Table 16.—Anti-Submarine Warfare Technology: Criticality and Availability

a. Those technologies that are critical to ASW and are not commercially available are candidates to be controlled.

- Propulsion Design
- Low-Noise Machinery Design
- Sonar Dome
- Transducer Design
- Classification Techniques/Algorithms
- Acoustic Correlation Algorithms
- Contact Motion Analysis
- Tracker Design Algorithms
- Passive Ranging Techniques
- Weapon Guidance
- High-Density, Power-Pack Design
- Small-Size, High-Power Train Design
- Exotic Fuel Design
- Power Engineering
- Multipath Processing Techniques

b. Those technologies that are critical to ASW and are not commercially available are candidates to be controlled. However, a lesser technology will provide either a significant ASW capability without these techniques or a more primitive version of the technique.

- Low-Speed Turbines
- Bearing Design
- Baffle Design
- Beamformer Techniques
- Local Area Network Design
- Spectrum Analyzer Design
- Microelectronic Design
- Beamformer Design
- High-Speed Graphic Techniques
- Color/Bit Plane Graphics
- Shape Charge Techniques
- Fusing Design
- Magnetic Anomaly Detection

c. Those technologies that are critical to ASW but that are so available commercially that controls would be futile.

- Corrosion Resistance
- Ceramic Design
- Elastomer Technology
- Machinery Isolation
- Spectral Analysis Algorithms
- Acoustic Performance Prediction Techniques
- Environmental Sampling Techniques
- High-Speed Math Processor Design
- Minicomputer Design
- High-Explosive Technology

d. Those technologies that are not believed to be critical today but may be in the future.

- Transient Processor Design
- Satellite Environmental Observation
- Low-Probability-of-Intercept Techniques
- Active Sonar Processing
- Adaptive Processing
- Quiet Weapon Launch Design
- Lightweight Structure
- Sensor Technology
- Quiet Weapon Propulsion
- Acoustic Miniaturization
- Adaptive Noise Cancellation
- Transient Analysis
- Automated Detection Algorithms
- Automated Trackers Algorithms
- Automated Classification Algorithms
- Hull Design
- Boundary-Layer Control
- Pipe-Flow Design
- Damping Material Design
- Man-Machine Techniques
- Large-Field Graphic Design
- Pulse-Forming Design
- Rapid Transient Design

SOURCE: Adapted from "Assessment of ASW Technology Transfer to the People's Republic of China," contractor report prepared for OTA by Global Associates, Ltd., Alexandria, VA, Dec. 17, 1986.

be easier to relate to specific equipment than are the present criteria.

While it is obvious that either change would ease the burden on DOC and exporters such as Hewlett-Packard, the degree to which it would increase sales is not easily determined. China is unlikely to start buying many more spectrum analyzers for commercial purposes just because it can get prompter delivery with less licensing uncertainty. In so far as the United States is more stringent in approving borderline applications than other countries, moving some models to the green zone would improve American competitiveness. However, it is not clear that this has been an important factor for spectrum analyzers. It is possible that some sales are now lost when license applications are mistakenly treated as above the green zone. Raising the limit would make this less likely for those models. As of January 1987, applications were pending for more than 60 days for 170 spectrum analyzers of all types, but only a few were real-time analyzers. Typical prices for spectrum analyzers are in the range of $10,000 to $40,000. If the total sales to China of real-time spectrum analyzers were on the order of $1 million per year, liberalizing the limits might add as much as several hundred thousand dollars.

The other half of the equation—the effect of liberalizing controls on China's military—is no easier to answer. Even quite sophisticated

Box B.—Spectrum Analyzers

Spectrum analyzers are electronic instruments used to display and measure the frequency and amplitude of electromagnetic waves. They are used by industry for vibration analysis of machinery or in the manufacture of electronic equipment such as disk drives, and other applications. There are two types of commercially available spectrum analyzers. The "swept tuned" analyzer has fewer restrictions for sale to China, and, not being applicable to ASW, will not be discussed here. The "FFT-based" spectrum analyzer can be used for ASW because it is faster in the required frequency range.

In their simplest form, spectrum analyzers convert an electromagnetic signal into a series of sine waves through a process known as Fast Fourier Transforms (FFT). If an ordinary power line is analyzed, the spectrum analyzer shows essentially a single sine wave at 60 Hz.[1] A more complex signal would be shown to be composed of several or many sine waves of different frequencies and energy levels. The pattern of these component sine waves reveals much information about the original generation of the incoming signal.

Spectrum analyzers can operate at low frequencies (approaching zero Hertz (Hz), commonly referred to as direct current), up to microwave frequencies of 300 GHz. Current technology does not permit a single instrument to operate over this entire range so spectrum analyzers are designed to operate over specific ranges, such as 0 to 100 kHz or 5 to 50 kHz. In addition to operating over different frequency ranges (bandwidths), models differ in the accuracy and resolution with which they measure the amplitude and frequency of input signals, in their processing speeds and capabilities, in programmability, and in the number of signals they can analyze at any given time.

The major concern in determining whether a spectrum analyzer should be subject to export restrictions is whether it can make "real-time" measurements. That is, whether the instrument can continuously acquire and transform rapidly changing data (e.g., voice signals) fast enough that no data is lost or ignored. Many commercial spectrum analyzers can make real-time measurements on data that changes up to 10,000 times a second (i.e., 10 kHz). Some are capable of faster operation.

As noted in tables 15 and 16 on anti-submarine warfare, spectrum analysis is a key part of the sonar system that detects and classifies the target. Each type of submarine produces acoustic emissions which are characteristic of its machinery and hull design. These emissions are received and displayed on a spectrum analyzer, where they can be compared with known emission patterns of various submarines to identify the type.

Real-time spectrum analyzers are included in Commodity Control List (CCL) category 1529, which has an advisory note "licenses are likely to be approved for export to satisfactory end-users in the People's Republic of China of the following equipment: . . . spectrum analyzers employing time compression of the input signal or Fast Fourier Transform techniques not capable of: 1) Analyzing signals with a frequency of greater than 100 kHz if the instrument uses time compression, or 2) Calculating 512 complex lines in less than 50 ms [milliseconds]." The latter requirement says in effect that a spectrum analyzer is green zone if it is not capable of real-time analysis above about 10 kHz, but putting this criterion into practice is not straightforward. There appears to be room for disagreement on whether specific models comply. The Department of Commerce reports that it has been able to get spectrum analyzers approved for export to China that have been as fast as 512 complex lines in 4 milliseconds. This represents a de facto red line, at least at present.

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[1] Hz stands for Hertz, or cycles per second. The human ear can detect sound waves in the spectrum of 20 to 20,000 Hz. Sound waves can be converted to electromagnetic waves by a microphone for display on a spectrum analyzer, but audio spectrum analyzers can also operate on a much broader range of frequencies: up to 300,000 Hz (300 kHz). Other types of spectrum analyzers operate in the range of millions of Hertz (MHz) or billions (GHz).

Photo credit: Hewlett Packard

The Hewlett Packard model 3562A dynamic signal analyzer is being used for spectrum analysis of electronic equipment. This model is too fast and sophisticated to qualify under the present green zone criteria.

spectrum analyzers have already been sold to China, though only after the license application has been approved by DoD and COCOM (taking into account the end user, intended application, and the capabilities of the particular model in question.) One such model was sold to a People's Liberation Army hospital. However, design and manufacturing information is unlikely to be transferred, and spectrum analyzers would be extremely difficult for China to reverse-engineer and manufacture. The concern over the export of equipment is that China could divert these relatively sophisticated spectrum analyzers (along with other equipment) to develop a greatly enhanced ASW system. The present system provides some control over the numbers exported to China and information on their whereabouts, thus limiting the number that China could divert to military applications.

The question on the military implications comes down to whether the United States cares if China has access to a large number of spectrum analyzers with capabilities somewhat above those in the present green zone. Several viewpoints can be taken. A moderate relaxation of the 50 ms criteria (perhaps to 20 ms) or a change to the 10-kHz real-time bandwidth criterion would not contribute to ASW capabilities that would interfere with U.S. submarine operations. Similarly, new U.S.S.R. subs are much quieter than older ones and presumably would also not be vulnerable to such a system, but Soviet planning would be complicated if it had to replace older subs patrolling the China coast with new ones to evade the new ASW system. However, Taiwan has several older subs that could be jeopardized in the event of an attempt by the mainland to forcibly reunite the country. Thus a decision on revision of export controls is a function of technology, political questions, and military strategy.

Given the obvious weaknesses of China's military, there are many dual-use technologies (particularly those that improve defensive capabilities) now restricted that could be transferred without significant effects on China's position vis-a-vis other Asian countries. Some types of dual-use technologies however, have not been transferred, but could have widespread and significant effects on China's military capability if successfully adapted and assimilated.

Consider a hypothetical Chinese request for a supercomputer. Powerful computers such as the Cray-2 are used in processing large amounts of data (satellite imaging and acoustical intelligence).[24] But the Chinese would not necessarily be able to use a supercomputer effectively for those purposes if they were to obtain one in the near future. Chinese scientists and technicians would need complicated software and highly specialized algorithms to use a supercomputer for such purposes. Chinese computer scientists might be able to produce useful software for specialized purposes such as nuclear weapons design, but for many years it would not be as sophisticated and powerful as that used in the United States. A variety of safeguards (presence of U.S. technicians around the clock, repairs and maintenence by U.S. personnel, no dial-up capability from other machines) could be used to limit unauthorized access to a supercomputer.

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[24] The Chinese-made supercomputer called the Galaxy does not compare with the Cray-2 in speed and power as discussed in app. 2, vol. II of this report.

On the other hand, no safeguard provides a perfect guarantee. China's military capabilities could be improved by use of a supercomputer, but the degree would depend on the applications to which the supercomputer would be put. Judgments about whether improved Chinese intelligence gathering (for example) would pose a risk to the United States or to other Asian countries depend fundamentally on assessments of China's political and strategic goals and policies.

Export control decisions are also complicated by Japanese production of supercomputers comparable in many ways to those made in the United States. New approaches such as parallel processing, moreover, will eventually make it possible to combine smaller machines so that they can perform the functions of a supercomputer.

More common than the example of the supercomputer (where the applications are widespread) are other decisions about items that in isolation are likely to have much more limited effects. Laser gyroscopes, to take one example, are used for inertial navigation by both civilian and military aircraft and for strategic missile guidance. Improving the accuracy of China's missiles requires gyroscopes, but the acquisition of a handful of these items would probably not produce dramatic changes. Improvements in mapping, for example, would also be essential. While gyroscopes could theoretically be reverse-engineered, their construction requires a special type of glass produced only in the United States and Japan. The risks associated with transferring a small number of such items are thus mitigated (but not eliminated) by such factors.

In the near term, U.S. export administrators may find themselves pulled in two directions. In light of the many weak points in China's military, the transfer of small numbers of items alone may not appear to pose a significant threat to the United States. Moreover, a friendly China more able to deter Soviet aggression may be seen by the United States and other Asian countries as more an asset than a liability. Cooperating with China in civilian and military technology transfer may also permit expanded knowledge of China's system and strageic thinking.

On the other hand, periodic assessments must be made about whether a step-level improvement has taken place in a military mission area because of incremental changes. Numerous "routine" transfers by the United States and other suppliers may result in a significant improvement in a particular military operation without an overall U.S. policy assessment that assisting China in this way is desirable. Even if such improvements have no effect on China's capability vis-à-vis the United States or the Soviet Union, which seems likely, they could affect China's military balance with other Asian countries.

As China modernizes its military and economy, neighboring countries may expand military expenditures in response to, or demand equal treatment in arms sales from, the United States. China will become an increasingly important regional power. Globally, China may be in a key position as a larger arms seller and potential transferor of military technologies. Therefore, the nature and scope of China's own export policies will be important to Western interests.

An important caveat is, however, appropriate. Firms from many Western countries can supply military and dual-use technologies to China. There is room for national discretion on export policy within the bounds of the Coordinating Committee for Multilateral Export Controls system. In addition, and potentially more important, China is not restricted to COCOM countries for the purchase of advanced technologies. Other developing countries may re-export equipment which they have purchased from COCOM countries or which they have produced themselves. The ability of the United States to restrict China's military modernization unilaterally is therefore quite limited.

Conclusion

China cannot become a military superpower by year 2000, but it will be increasingly able to play a more influential role in Asia if current policies achieve their goals. The United States and China thus today share mutual interests in ensuring peace and stability in Asia during the next 15 years. From the Chinese perspective, a policy designed to support such a climate is the most promising avenue to eventual military modernization (given the wide range of China's military shortcomings). Yet, even if current policies are maintained, China's interests are by no means identical to those of United States or other friendly countries in Asia. How China will choose to exercise its power will remain an important question for U.S. policy makers that lends an element of caution to U.S. debates over technology transfers.

The level of technology transfers (dual-use and military) in the best U.S. national interests will not be constant. China will ask for more sophisticated computers, telecommunications, and manufacturing technologies, and other Western suppliers will probably be eager to sell. Military cooperation will cover a range of activities including visits by defense delegations, exchange of intelligence information, port calls, and other more symbolic interactions, as well as fuller involvement via coproduction and assistance in modernizing entire weapons systems. The latter clearly holds a much stronger potential for improving China's military capability. Without a clear policy framework during this intermediate period, expectations may be raised and then dashed, with adverse political repercussions. U.S. exporters and license examiners need clear guidance from policy makers.

U.S. technology transfer policies will continue to involve a delicate balance: promoting trade and technology transfer in many areas while maintaining controls on exports of the most militarily sensitive equipment and technologies. Decisions about transferring technology routinely hinge on a variety of technical judgments, but policies must be based on a reading of broader political and economic developments. Uncertainty about the future shape of China's policies and military strategy will undoubtedly introduce an element of restraint in a technology transfer policy that is generally designed to promote fuller interaction between the United States and China.

THE ASIAN SECURITY ENVIRONMENT

The significance of the issues surrounding Chinese military modernization must be seen in the context of the Asian security environment. Since the U.S. withdrawal from Vietnam in 1974, the East and Southeast Asian region has enjoyed an era of stability and relative peace. The war in Kampuchea, involving Vietnamese troops and the Khmer resistance forces opposing the rule of the Vietnamese-backed Heng Samrin regime, has been the main conflict in the region in recent years, a conflict that also led to the Chinese punitive attack on Vietnam in 1979. For most of the countries of East and Southeast Asia, however, the recent past has been a time of peace and stability, which has been welcomed by the countries of the region as a necessary condition for the remarkable economic growth that many of them have experienced.

Nevertheless, there are continuing tensions in the region, and serious security problems that remain unresolved. The United States and other countries in the region view the growth of Soviet military power in the Pacific as the chief threat to regional security. The most active destabilizing situation is the Kampuchean problem, with its implications for the security

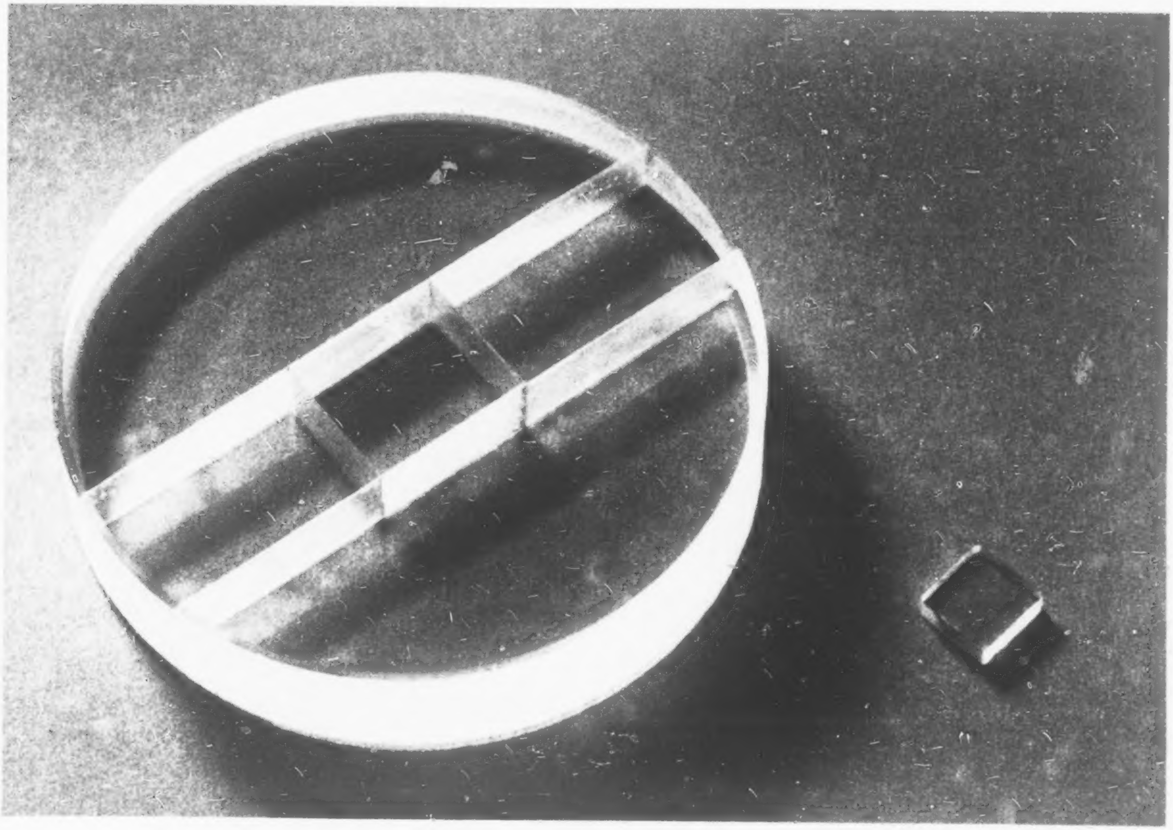

Photo credit: Electro Scientific Industries, Inc.

Potassium/Titanyl/Phosphate (K.T.P.) crystals used in lasers. The small one is from the only U.S. manufacturer. The large one was made in China and is of significantly higher quality. U.S. export controls prevent these crystals from being exported to China even though they are made there.

of Thailand and the other Association of Southeast Asian Nations (ASEAN) states and for Sino-Soviet rivalry in the region. The situation on the Korean peninsula and the Taiwan problem also indicate unresolved tensions that could lead to armed conflict. Some of the potential conflicts—most notably those in Korea and along the Sino-Soviet border—are of global significance.

Perceptions of security threats differ in important ways from country to country. Four great powers—the United States, the Soviet Union, Japan, and China—have active interests in the region. The perceptions of these nations differ, sometimes significantly. Add to these the varying perspectives of the smaller states such as Korea and Singapore and those of an aspiring power such as Indonesia and it becomes clear that interests in Asian security are quite complicated.

The powers in the region have concerns about unpredictable trends. The United States, China, and Japan, for instance, are unsure of Soviet intentions under Gorbachev. The Soviets are concerned about the direction of Japanese security thinking and future behavior. The course of U.S.-China relations, and whether the latter will have a military dimension that would be threatening to the Soviet Union, is of particular concern to Moscow. The

United States and Japan, as well as the Soviet Union, have active interests in China's future course.

The powers in the region are also concerned that the strategic rivalry between the United States and the Soviet Union may intensify the arms race in Asia and the Pacific, involving allied nations as well as the superpowers. Moreover, U.S.-Soviet conflicts in other regions could spill over into Asia. In this sense, Asian regional security is very much related to the global U.S.-Soviet competition, both affecting and being affected by it.[25]

Of greatest concern to the United States has been the growth of Soviet power in the region. Since the end of the Vietnam war, Soviet military assets have increased substantially as Moscow strengthens its eastern defenses and becomes an Asian/Pacific power. The Soviet naval buildup in the Pacific, including 90 surface warships, 135 submarines (65 of which are nuclear powered), and two of its three aircraft carriers, threatens the naval dominance long enjoyed by the U.S. 7th Fleet.[26] The Soviet Union benefitted from the U.S. withdrawal from Vietnam by acquiring permanent air and naval facilities at Danang and Cam Ranh Bay. A squadron of MiG-23s based in Vietnam can provide air cover for the 8 TU-95 *Bear D* reconnaissance planes and 16 TU-95 *Badger* bombers also based there. Ten of the *Badgers* have cruise missile capabilities, and the United States believes that the Soviets may increase their number to 30. The *Badgers* have a combat radius sufficient to extend to all ASEAN states.[27]

Today, between 25 and 30 Soviet warships are likely to call at Cam Ranh Bay at any one time. This contrasts with 1979, when the Soviet Pacific Fleet cruised into the waters of the South China Sea only occasionally.[28] The overall buildup of Soviet forces in the Pacific, in combination with the basing opportunities in Vietnam, gives the Soviet Union power projection capabilities into the Indian Ocean from the Pacific (as well as from its bases in Yemen and Ethiopia).

The Soviets deploy an estimated 40 divisions (370,000 troops) along the Sino-Soviet border. Other Soviet assets in the region include some 2,200 combat aircraft, an estimated 135 SS-20 intermediate-range ballistic missiles (as well as SS-18s and air-launched strategic missiles), and submarine-launched ballistic missiles from submarines on station in the Sea of Okhotsk.[29] More recently, Soviet influence has been extended to the South Pacific with the signing of a fishing agreement with Kiribati that provides for annual payments by the Soviet Union to fish in the economic exclusion zone claimed by Kiribati. Negotiations for a similar agreement are under way with Fiji. The nation of Vanuatu has established relations with the Soviet Union and Libya (and receives foreign assistance from Vietnam and Cuba).[30]

From the Soviet point of view, of course, its military build-up is in response to what it perceives to be a U.S. strategy of "total military control" of Asia and the Pacific. The Soviets see the United States stationing more than 2,000 nuclear warheads in the region, expanding and diversifying the delivery systems for them, working with allies to modernize conventional forces, and extending political influence with other friendly states.[31] All this is occurring in the context of improved U.S.-China relations and talk of Sino-American military cooperation.

Soviet political influence has thus far failed to match the buildup of its military assets. Yet, Moscow has attempted to put a new face on its diplomacy in the area. Efforts to improve relations with Japan, and perhaps ease it somewhat away from its pro-U.S. orientation, are evident in the visit to Tokyo of Foreign Minister Shevardnadze in January 1986, the first such visit in 10 years. Efforts to win influence among the ASEAN states are also being made with promises of markets for ASEAN products and claims of support for the ASEAN objective of creating a Zone of Peace, Freedom, and Neutrality (ZOPRAN). These initiatives have not had strikingly positive results for the Soviets to date.

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[25] David Holloway, "U.S.-Soviet Strategic Competition and the Security of Northeast Asia," *Prospects for Peace and Cooperation in the Asia-Pacific Region*, A Special Report of the Center for International Security and Arms Control (Stanford, CA: Stanford University, March 1986), pp. 18-19.

[26] Masashi Nishihara *East Asian Security* (New York: New York University Press, 1985), p. 30; See also, William Branigin, "Soviet Military Operations Seen Increasing in the Pacific," *The Washington Post*, Aug. 1, 1986, p. A17.

[27] Donald S. Zagoria, "The USSR in Asia in 1985," *Asian Survey*, vol. XXVI, No. 1, January 1986, p. 22.

[28] Ibid.

[29] Ibid.

[30] Asian Studies Center, *Backgrounder*, No. 48 (Washington, DC: The Heritage Foundation, July 24, 1986), pp. 8-9.

[31] See Zagoria, op. cit.

Soviet leader Gorbachev's July 28, 1986 speech in Vladivostok is a sign of the increasing importance the Soviet Union is attaching to the extension of its political influence to Asia and the Pacific. In his speech, Gorbachev proposed the withdrawal of Soviet troops from Mongolia and withdrawal of 6,000 of the more than 115,000 troops in Afghanistan. He also offered to negotiate with the Chinese for the reduction of forces along the Sino-Soviet border. The speech was silent however on Soviet support for Vietnamese actions in Kampuchea, a subject of primary concern to the Chinese, although it implied a willingness to consider the future role of Soviet forces at Cam Ranh Bay if the United States was willing to withdraw from the bases in the Philippines. Finally, Gorbachev indicated a desire for improved relations with Japan, including further high-level meetings.[32]

The two areas where the growth of Soviet influence has been most evident are Vietnam and Korea. The aid given to Vietnam, without which the latter could not prosecute the war in Kampuchea, is believed to give the Soviet Union considerable leverage with the Vietnamese. Military aid, including a squadron of MiG-23s, has also been used to increase Soviet influence in North Korea during the last few years. While Chinese influence in Pyongyang throughout the 1970s surpassed that of Moscow's, North Korean disaffection with the reform program in China and China's opening to the capitalist world (including unofficial trade with South Korea) presented the Soviet Union with an opportunity to compete (successfully, as it is turning out) for influence with the North Koreans.[33] Improved Moscow-Pyongyang relations, for instance, have reportedly led to North Korea granting overflight and landing rights to the Soviets for reconnaissance flights along the Chinese coast.[34]

In addition to the tensions in Indochina and the balance of power on the Korean peninsula, other factors are germane to the security of the region. These include tensions along the Sino-Soviet border and the uncertain future of Taiwan. While the former have eased in the last few years, and both China and the Soviet Union seem to want a further reduction in tension, large numbers of Soviet troops are still deployed along the border, and China still regards the Soviet Union as the chief threat to its security. Although China has shown a willingness to temper its statements about the future of Taiwan, the Taiwan issue (discussed further, below) remains volatile—subject to unpredictable domestic political forces in the United States, China, and Taiwan—and is thus a potential threat to U.S.-China relations.

There are also unresolved territorial disputes between some of the countries in the region of the East and South China Seas. The unresolved dispute over the Kuril Islands to the north of Japan occupied by the Soviets since the end of World War II, for instance, continues to be a major stumbling block to the improvement of Soviet-Japanese relations.

Economic factors are very important for the stability of the region. Many of the countries are experiencing structural transitions in their economies, hoping to move to higher value-added production. These transitions, however, are occurring at a time when the assured export markets, which played such an important role in past growth, can no longer be taken for granted, and when increased intraregional economic competition seems likely.

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[32] Don Oberdorfer, "U.S. Analyzes Gorbachev's Bid to China," *The Washington Post*, July 30, 1986, p. 15.

[33] Robert G. Sutter, "Beijing's Relations With Vietnam and Korea—Implications for Future Change in PRC Foreign Policy," paper presented at the Fifteenth Sino-American Conference on Mainland China, Taipei, June 8-14, 1986.

[34] Paul H. Kreisberg, "The United States and Asia in 1985," *Asian Survey*, vol. XXVI, No. 1, January 1986, p. 8.

China's Security Interests and Foreign Policy

For many of the nations of the region, China's future role in regional security remains a major question mark. A more modernized China will be a stronger China, and U.S. technology transfer policy is contributing to this modernization. Assessing China's likely role in Asian security is complicated by the unpredictability of the security issues in the area.

The increasing inseparability of economic issues from more traditional security concerns must also be considered in analyzing China's likely international behavior. This confluence of the economic and the military/strategic is occurring at a time when the established free-trade regime is under great pressure, a pressure unlikely to be diminished by China's increasing, international, economic role. Nevertheless, an important factor underlying the new orientation in Chinese foreign policy is the benefit Chinese leaders expect from participation in the international economy. The uncertain future of the free-trade regime complicates our ability to understand and predict China's likely impact on the region. The maintenance of a free-trade regime, and open markets in the industrialized world for Chinese products, for instance, may have much more to do with the kind of security role China plays in the region than the course of Chinese military modernization.

Despite the many differences between current Chinese foreign policy and that of the late Maoist era, when China's prime international commitments seemed to be to support wars of national liberation and to oppose the United States and the Soviet Union, there are certain constants in past and present approaches, and the roots of the latter are clearly found in the former.

Chinese foreign policy shows the combined influences of domestic and international factors. Among the former are such issues as the relative influence of politics in policy, the role of ideology, and the influence of the Chinese past. Among the latter are the basic distributions of power in the international system, the regional context, and the relationships between China's foreign policy aspirations and its capability to project influence abroad.[35]

During the Maoist era, foreign policy showed the influence of Mao's preoccupation with "politics in command," a tendency to see foreign policy through ideological lenses, and a view of the past that explained China's relative weakness in terms of the exploitation it suffered at the hands of the imperialists. Politics and ideology have certainly not been fully expunged from current policy, but clearly economic considerations have also emerged as central factors. Old ideological formulations have been questioned, and a spirit of open pragmatism is much more in evidence today. While the Chinese have not forgotten the legacy of Western imperialism (it is unlikely they ever will), there is also in evidence a self-criticism about China's own responsibilities for its failure to modernize, and thus for its relative weakness.

In the Maoist period, the international strategic environment was seen as one of clear bipolarity, with both superpowers deserving of critical appraisal and condemnation for attempted hegemony. The Asian region was seen as an underdeveloped area ripe for revolution. By allying itself with revolutionary forces abroad, China could serve its ideological beliefs, make common cause with others in opposing superpower hegemony, and extend its influence within the constraints of its resources and power potential.

In the post-Mao era, China seems unsure of the extent to which bipolarity has eroded, but recognizes a new interdependence in the international environment. This new environment makes possible a strategy of pursuing security by balancing one superpower against another. Similarly, the Asian region can no longer be seen as an undeveloped area ripe for revolution. It is instead a dynamic instance of modernization, serving as a counter example to Chinese experience of what successful economic development and modernization can be. China thus not only studies the experiences of some of its capitalist Asian neighbors, but also wishes to cooperate with them and, in some ways, emulate them. In the process, it has discovered that the projection of influence in support of national interest can be accomplished by means other than military might and the export of revolution.

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[35] Thomas W. Robinson, "China's Foreign Policy, Beijing's Military Modernization and American Policy Alternatives," app. 8 in vol. II of this report, December 1986.

A central issue in assessing China's perceptions of its security interests and its role in Asian security is how it sees its relations with the United States and the Soviet Union. China in the 1960s saw threats to its security from both the United States in Southeast Asia and from the Soviet Union on its northern border. The Soviet invasion of Czechoslovakia in 1968, followed by the Sino-Soviet border clashes of 1969, convinced the Chinese that the greatest threat came from the Soviets. This led to the Chinese desire to explore the improvement of relations with the United States. Throughout the 1970s, the Chinese continued to hold to the view that the Soviets posed the greater danger.

The Chinese today see the United States and the Soviet Union locked in a grand strategic competition in the region. They see the Soviets as trying to strengthen their eastern forces and to insure sea passages to link their eastern and western fronts in an effort to thwart United States attempts to encircle, isolate, and restrict the exercise of Soviet influence in Asia. To achieve this end, the Chinese see the Soviets as striving to undermine U.S. influence with the nations in the region and to threaten the security of U.S. sea lanes of communication.[36]

In the Chinese view, the United States seeks to complicate Soviet planning by creating the possibility of a two front war in Europe and in Asia. Both superpowers are seen pursuing strategies that employ military buildups, competition for the control of the sea lanes, and closer military and political cooperation with their respective allies in the region.[37]

China continues to be most concerned about Soviet power in Asia and uses its relationship with the United States, Japan, and other states to counteract those potential uses of Soviet power and influence that would be harmful to Chinese interests. Thus, there is a strong confluence of interest between the United States and China, for instance, on the general buildup of Soviet Asian/Pacific forces and on the particular expansion of Soviet influence in Indochina and Afghanistan. China is also concerned that instability on the Korean peninsula will lead to the growth of Soviet influence there, as well.

In recent years, China has moderated its stand on the danger of Soviet expansionism. This became especially evident in 1981-82, when the issue of continued U.S. arms sales to Taiwan threatened U.S.-China relations. China is thus concerned that it not become too close to the United States. To do so would create domestic problems (in light of the sensitivity of the Taiwan issue), would be viewed by the Soviets as threatening, and would compromise China's position as an erstwhile spokesman for the interests of the Third World.[38]

China since 1982 has therefore attempted to make clear that it pursues an "independent" foreign policy of "equidistance" between the two superpowers. Sino-Soviet relations have improved with the signing of economic, trade, and science and technology agreements during the 1984 visit to Beijing of First Deputy Premier Arkhipov, and the signing of additional agreements for economic cooperation during the Yao Yilin visit to Moscow in 1985. The latter included an agreement providing for $14 billion of trade during the next 5 years. A second agreement involves Soviet help in building 7 new plants in China, and in renovating 17 others built under the terms of Sino-Soviet cooperation in the 1950s.[39]

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[36] Xie Wenqing, "Soviet and U.S. Military Strategies in the Asian-Pacific Region," *Prospects for Peace and Cooperation in the Asian-Pacific Region*, Conference 1985, p. 25.

[37] Ibid.

[38] It is also possible that China viewed its interests in a manner analogous to classical Western balance-of-power thinking. As the Reagan Administration increased both the will and the ability of the United States to confront the Soviet Union, China maintained the balance by shifting from a pro-U.S. to a more neutral posture.

[39] Zagoria, op. cit., pp. 15-16.

The Chinese also indicated a willingness to relax their insistence that any further improvement in relations would require Moscow to withdraw from Afganistan, reduce its troops along the Sino-Soviet border, and discontinue support for the Vietnamese actions in Kampuchea.[40] The July 28, 1986 Gorbachev speech would indicate that the Soviets are prepared to meet the Chinese at least part way on these terms, and Deng Xioaping's offer in September 1986 to meet with Gorbachev would indicate there is considerably more fluidity in Sino-Soviet relations than in the past.[41]

It is generally assumed that the softening of the Chinese position on the Soviet Union has been due to dissatisfaction with U.S. policy on arms sales to Taiwan, as well as a reflection of the influence of some in the Chinese leadership, such as Chen Yun, who are skeptical of moving too close to Washington. It is likely that the Chinese wish to relieve tensions with Moscow to reduce dependence on the United States, and they may see the dawn of the Gorbachev era as a prime opportunity.[42]

Despite improvements in Sino-Soviet relations, there are reasons to assume that China still sees its interests as being closer to those of the United States. China recognizes that the United States does not pose any direct threat, as does the Soviet Union with its military deployments along the Sino-Soviet border, and that the United States offers the Chinese access to modern science and advanced technology unavailable from the Soviet Union.

With regard to China's perceptions of its own interests in the region, Chinese policy statements have emphasized the importance of peace and stability as conditions necessary for the economic development and modernization not only of China, but of other countries as well. China has accordingly tried to develop good relations with the countries of Southeast Asia (except Vietnam), and to this end has reversed its long-standing support for Communist movements in the area. It places great value on its relations with Japan, its largest trading partner and source of foreign assistance, and has softened its stance on South Korea. The themes of Chinese policy seem to be to foster the conditions for mutually productive economic interchange and to check the expansion of Soviet and Vietnamese power and influence in the area.

Photo credit: Xinhua News Agency

Installing a Chinese-made manipulator, which will be used in handling radioactive isotopes.

Two other changes mark the new direction of foreign policy in the post-Mao era. The first is the growth of Chinese participation in international organizations. China's membership in the United Nations, the World Bank, the Asian Development Bank, the International Atomic Energy Agency and other organizations, as well as its interest in joining the General Agreement on Tariffs and Trade, has increased its stake in the stability of the international system and is a formal indication of increasing interdependence.

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[40] Ibid.

[41] Deng's offer, however, contains the precondition that the Soviets demonstrate their willingness to use their influence in support of the removal of Vietnamese troops from Kampuchea, a step which the Soviets may be unwilling and unable to take. See Daniel Southerland, "Chinese Leader Offers To Meet Gorbachev," *The Washington Post*, Sept. 7, 1986, p. A21

[42] For an exploration of China's shifting positions *vis à vis* the superpowers, see Robert S. Ross, "International Bargaining and Domestic Politics: U.S.-China Relations Since 1972," *World Politics*, vol. 38, January 1986, pp. 255-287; and Harold C. Hinton, "Teng Hsiao-p'ing's Management of the Superpowers," paper presented at the Fifteenth Sino-American Conference on Mainland China, Taipei, June 8-14, 1986.

The second change is the significant modification of the operation of China's foreign policy machinery. The latter has clearly become more institutionalized and professionalized in recent years. While it certainly has not removed domestic politics from the process of foreign policy making, the system is markedly more regularized and deliberative than the "politics in command" style of the Maoist era.[43]

There is considerable agreement among foreign observers that through a combination of deft diplomacy and a commitment to the development of strategic weapons for deterrence, China is satisfying its security needs. Although China's own conventional armed forces have yet to be modernized, and Soviet forces in the Asia/Pacific region are a potential threat, the probability of hostile actions being directed against China has been reduced. Indeed, as one observer put it, China's relations with the superpowers are much better than the superpowers' relations are with each other.[44]

China's response to superpower competition is also influenced by its own resource base and level of modernization. Given the numbers and sophistication of weapons possessed by the superpowers, China, to compete, would require investments in military modernization that would almost certainly doom programs for the modernization of industry, agriculture, and science and technology. Even with such military investments, it is likely that China would still be in a relatively weaker position vis-à-vis the superpowers, whose own weaponry would continue to develop. Thus, China's current course of "managing" the superpowers diplomatically, while still maintaining a nuclear deterrent (however modest), can be seen as a rational response to the cardinal power relations in the international system.

The questions many foreign observers ask of Chinese foreign policy are how stable this current course is, and what could lead the Chinese in less friendly and constructive directions? Chinese foreign policy has not been entirely consistent, especially with regard to the important issue of relations with the superpowers. Inconsistency is worrisome in light of the consequences of a successful modernization program. A modernized China will be richer, stronger, and more capable—a nation better able to insist on its way in both world and regional military/economic affairs. Such a China would be able to upset the balance of power in Asia and could be a threat to U.S. interests. This question is next considered in the context of the major "arenas" of Chinese foreign policy.

Asian National Interest in China's Modernization

There are wide differences in the particular security interests of East Asian nations, although generally shared interests can also be identified. These interests are summarized below. To identify common security interests about China's modernization, countries will be discussed by geographical subregion: Northeast Asia, Southeast Asia, and South Asia. Taiwan will be discussed separately. The main focus will be on factors most likely to threaten the security of each of these geographic areas. The reasons why some of these threats might be ameliorated by the interaction of Chinese and other varied national interests and capabilities in the region will also be discussed.

Northeast Asia

China's relations with its neighbors to the Northeast (Japan, South Korea, and North Korea) have ranged from cordial to bloody, though neither the Korean War nor World War II was instigated by China. In recent years, regional stability has been threatened more by the growing presence of the Soviet Union and by concerns over North Korea's intentions, but not by Chinese aggressiveness.[45]

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[43] A. Doak Barnett, *The Making of Foreign Policy in China* (Boulder, CO and London: Westview Press, 1985).

[44] Donald Zagoria, "Recent Trends in Sino-Soviet Relations and the Strategic Triangle," paper presented to the Fifteenth Sino-American Conference on Mainland China, Taipei, June 8-14, 1986.

Japan has been increasingly willing to play a greater role in its own defense, but its priority has been to expand its trade and political relations in the region. Therefore, Japan's security goals seem to be consistent with the apparent goals and modernization requirements of China. The greatest Japanese security concern is the Soviet military presence in the region. The Soviet Union has continued to refuse to discuss the status of the four Soviet-occupied northern islands that Japan claims. It continues to assert its military presence from its naval and air bases on its coast above Japan, and it is increasing its military support of North Korea.[46]

Japan exhibits some cautiousness toward, but does not appear to feel threatened by, China. Thus, for example, it has been willing to sell nuclear powerplant equipment and technology to China while requiring China to agree to restrict the application of these technologies to peaceful uses. Japan does not appear to feel any significant new threat to its security in the region, but it has recently taken steps to increase its role in defending itself. In 1985, Japanese decisionmakers announced that they would increase military spending by 5.4 percent per year for 5 years, beginning in 1986. This would exceed the decade-old policy of holding military spending to one percent of GNP.[47]

Chinese-South Korean relations have been slowly improving, though many differences remain. Indirect trade between the two countries has been increasing. China has also shown a willingness to send athletic teams to South Korea, as seen in the Asia Games and in China's plans to attend the Olympics. In addition, South Korea has shown increasing willingness to cooperate with China on defecting airplanes and naval vessels. Chinese and South Korean willingness to improve ties in these areas have been against the wishes of North Korea and, to a lesser degree, Taiwan. However, the greatest barrier to significantly improved relations is over issues of North and South Korean relations. China continues military ties with North Korea and generally supports its position on reunification talks, a posture unacceptable to the United States and South Korea.[48]

Chinese and North Korean relations have become less close in recent years, whereas North Korean and Soviet relations have improved. In 1985, after North Korea's first official visit to the Soviet Union since 1973, the Soviet Union began increasing its military aid to North Korea, including a squadron of MiG-23s. Reportedly, North Korea granted the Soviet Union overflight and landing rights for reconnaissance missions along China's coast. Gradual improvements in Chinese and Soviet relations and the prospect of force reductions on the Sino-Soviet border, however, have tended to lower the ability of North Korea to manipulate China and the Soviet Union by threatening to improve ties with either country.[49]

The main areas of North Korean concern about China have been: China's continued closer relations with Japan and the United States, both of which North Korea portrays as active threats to itself; China's slow cultivation of better relations with South Korea, especially in indirect trade and cultural contacts such as sports events; and the ideological threat from China's successful modernization, reform, and opening to the capitalist world. North Korea is also threatened by potential internal political struggles, since its paramount leader is now growing old.[50]

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[45] Robinson, op. cit., pp. 20, 28, 31, and 58.

[46] *Asian Yearbook 1986* (Hong Kong: The Far Eastern Economic Review, 1986), pp. 165-166; Donald S. Zagoria, "The USSR and Asia in 1985," *Asian Survey*, vol. XXVI, No. 1, January 1986, pp. 15-19.

[47] Ibid.

[48] Robinson, op. cit., pp. 30 and 35; and *Asian Yearbook 1986* (Hong Kong: The Far Eastern Economic Review, 1986), pp. 171, 174, and 175.

[49] Robinson, "China's Foreign Policy," op. cit., p. 35; *Asian Yearbook 1986*, p. 171; Also, in early 1987 Moscow announced a withdrawal of about 10,000 to 12,000 of its 70,000 troops in Mongolia, a symbolic, but potentially important development towards reducing Sino-Soviet border tensions. Celestine Bohlen, "Moscow Announces Troop Pullout," *Washington Post*, Jan. 16, 1987, p. A25.

For the reasons listed above, China's interests in Northeast Asian security seem to promote stabilility. While it continues to support North Korea, it opposes North Korean aggression against the South. It has good ties with Japan and is improving its ties with South Korea. It is improving its ties with the Soviet Union, but continues to oppose Soviet military gains in the region. If Sino-Soviet relations improve in a way that risks destabilizing the above noted balance or correlation of interests in Northeast Asia (an unlikely occurrence), the United States and East Asian countries would probably have adequate time and means to counter this threat.

Southeast Asia

On balance, China also appears to be playing a stabilizing role in Southeast Asian security. China's Southeast Asian security role centers mainly on the conflict in Indochina. Vietnam's military presence in Kampuchea and its relationship with the Soviet Union are the greatest security concerns in the region. Soviet bases in Vietnam have naval and air projection capabilities that extend to all ASEAN states.[51] As in Northeast Asia, China would be threatened by Soviet expansionistic goals in Southeast Asia. China is thus providing important military assistance to the Kampuchean resistance forces in coordination with aid from the United States and Thailand. However, some Southeast Asian nations view China's involvement as leading to an increased Chinese influence in the region and feel that China's interests may not always oppose Soviet goals.

Two other important factors should be noted. First, Vietnam is likely to feel threatened by improvements in Sino-Soviet ties. Troop reductions on the Sino-Soviet border would allow China to take stronger action in its periodic fighting with Vietnam. Such a move might even force Vietnam to be more accommodating with the West, with Southeast Asian countries, or possibly with China.[52]

Second, China has improved its relations with many Southeast Asian states. It has ended its support of the Thai Communist Party and has terminated aid to insurgents such as those in the Philippines. Relations with, and aid to, most other Communist parties in Southeast Asia have also been dramatically reduced. Although China insists on continuing "fraternal" relations with Indonesian, Malaysian, and Burmese Communist parties, it has largely discontinued material assistance to these three groups.[53]

Other security concerns have been raised by the influence of China over the ethnic Chinese populations in Southeast Asian states, especially in Indonesia, Singapore, and Malaysia, where the Chinese population is very large. Malaysia and Singapore, however, seem confident in their ability to defend themselves.[54] In addition, while Southeast Asian countries have also expressed fears about economic competition from China, these countries are increasingly investing in, trading with, and sending high-level delegations to China, showing that they feel they can manage and gain from improving relations with China.

Thus China is generally viewed as a stabilizing force in Southeast Asia. While it is viewed as desiring an increased role in Southeast Asian affairs, it offers a useful counterweight to an increased Soviet presence and Vietnamese aggression in Indochina. With the exception of Kampuchea, it has moved away from its past policies of support for groups that desire to overthrow Southeast Asian governments. Additionally, it has become a valuable trading partner for most of these countries.

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[50] Robinson, "China's Foreign Policy," p. 30; and Aidan Foster-Carter, "NorthSouth Talks Offer Hope for the Future," *Far Eastern Economic Review*, June 26, 1986, pp. 4445.

[51] See Zagoria, op. cit., p. 22.

[52] Robinson, op. cit., p. 37.

[53] *Asian Yearbook 1986*, pp. 119-122.

[54] Ibid.; and David Barber, "Phasing Out the Force," *The Far Eastern Economic Review*, Jan. 8, 1987, pp. 15-16.

South Asia

China's role in South Asian security is similar to that in the two East Asian sub-regions. In presenting both a potential source of opposition to some countries and opportunity for other countries involved in South Asia, China's role appears to have been stabilizing. The primary arena of South Asian security concerns have focused around Afghanistan. The Soviet invasion of Afghanistan in 1979 resulted in a hostile troop presence on Pakistan's west border. China has actively supported resistance forces against Soviet troops and the Soviet-supported regime in Afghanistan.[55]

China also counters Indian influence in the region while offering economic and trade opportunities for South Asian Countries. These factors have been important in the development of closer ties between China and Pakistan, Bangladesh, and Nepal.[56] China has assisted Pakistan with military hardware since 1960 and has given an informal guarantee of assistance in case of Indian attack.[57] An additional concern is that China has been accused of supplying technological assistance to Pakistan for producing a nuclear weapon. Although border disputes remain unresolved between China and India, and between Pakistan and India in a region bordering China, China supports negotiations, rather than use of force, for resolving these differences.[58]

The prospect of improved Sino-Soviet ties has not been ignored by India. Improved Sino-Soviet ties would tend to reduce the likelihood of China or the Soviet Union risking conflict with each other over Pakistani or Indian differences. As seen in the cases of North Korea and Vietnam, China and the Soviet Union might eventually cooperate to create disincentives for Pakistani and Indian use of force to solve differences. Thus, Indian decision makers have openly stated that they have "outgrown" the Soviet Union in economic and, to a somewhat lesser degree, security issues. India has also continued to diversify its sources of arms and advanced technology, as seen in its recent purchases of fighter jet engines from the United States. As relations stand at present, there is some chance that Western militarily useful technology could be diverted to the Soviet Union through India. This would exacerbate U.S.-Indian relations, and because of Chinese fears of India, it might also create problems in Sino-Indian and U.S.-Chinese relations.[59]

A view of South Asian security reveals a similar role for China, as seen in Northeast and Southeast Asia. China wants to counter Soviet gains in South Asia. It also wants to resolve disputes in the region by peaceful means. As in East Asia, trade has played a part in increasing relations between China and South Asian countries. Moreover, the prospect of improved Sino-Soviet ties has introduced a healthy awareness among South Asian countries of the security value of diversifying ties with other nations.

Taiwan

Taiwan is extremely concerned about the modernization of Mainland China's economy, technology, and military forces and expanding foreign ties. In contrast to China's other neighbors, Taiwan does not view the potential for expanded economic relations to be worth the perceived security risk. Statements by China about its stationing troops in Hong Kong in 1997, when it becomes a Special Administrative Region, have been used to challenge China's intentions in regaining Taiwan and other claimed territories.[60] Sino-Soviet rapprochement is also seen by the Taiwanese Government as evidence of China's unreliability.

However there are many reasons why China does not appear likely to attempt to take control of Taiwan by force. There is no sign of an anti-Taiwan military buildup,[61] and if one were to occur, there would likely be time to take various counteractive measures. The United States' Taiwan Relations Act mandated continued U.S. readiness to defend Taiwan.[62] In addition, the August 1982 Sino-American Communique on Taiwan allowed for continued U.S. arms sales to Taiwan, although at reduced levels, with a consideration for changes in the value of the dollar.[63]

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[55] Robinson, op. cit., pp. 34-35.

[56] On Bangladesh see *Asian Yearbook 1986*, Far East Economic Review, p. 110; and on Nepal see, Lok Raj Baral, "Nepal's Security Policy and South Asian Regionalism," *Asian Survey*, vol. XXVI, No. 11, November 1986, pp. 1218-1219.

[57] Robinson, op. cit., pp. 34-38, 50; and *Asian Yearbook 1986*, p. 99.

[58] Robinson, op. cit., pp. 50-57; and *Asian Yearbook 1986*, pp. 212-213.

[59] Robinson, op. cit., pp. 38-39; and Stuart Auerbach, "India Signs Agreement for U.S. Jet Engines," *The Washington Post*, Jan. 7, 1987, p. A16.

[60] *Asian Yearbook 1986*, p. 144.

Costs to China in taking military action against Taiwan would also be very high. One result would be a likely loss of important economic and technological benefits from trade with the United States, Western Europe, Japan, and other countries. Another result would be a significant loss in military forces, estimated at 40 percent of its front-line air force, a large number of ships, and casualties in the hundreds of thousands. Resistance on Taiwan would likely be great even if China "won." And, since the United States is committed to a stable security in the Taiwan straits, U.S. military involvement would also be risked.[64]

The more likely role a modernizing China will play in the security of Taiwan is less extreme. China is likely to continue to exert pressure on Taiwan to consider various arrangements for reunification.[65] As in the sale of Dutch submarines to Taiwan, China will probably continue to attempt to influence other nations to reduce military assistance to Taiwan.[66] In multilateral fora it seems likely that China will continue to attempt to lower the status of Taiwan.

Yet China will probably not want to jeopardize its foreign markets or tacit security understandings by being too hostile to Taiwan. For example, it will not necessarily attempt to exclude Taiwan from relations and international fora in a way that would be seen as threatening to isolate Taiwan. This would likely be the case where Taiwan's involvement is economically important, such as in the admission of China into the Asian Development Bank.[67] It would also seem to be the case in militarily important issues, as has been seen in China's recognition of the United States' desire for continued, though reduced, sales of weapons to Taiwan.

Further Issues

In conclusion, large-scale or sustained tension in Asia is unlikely, and China will probably play a stabilizing role in Asian security. This role is largely facilitated by China's interest in ensuring its access to foreign markets and its desire to have a stable environment in which to emphasize economic development. While China seems willing to improve relations with the Soviet Union, it appears that both countries' respective interests and commitments to their friends will prevent them from cooperating to destabilize the region. It is also likely that as China continues to improve its ties with Asian countries, its interest and role in promoting a stable region will grow even further. The willingness of most Asian countries to expand their political and trade relations with China indicates that they share this view.

A final issue is the possibility of shifts in foreign policy because of the present conflicts between Chinese leaders. In recent years, China's foreign policy course has served its modernization goals. If modernization becomes a less paramount goal, China could move back toward a more clearly socialist road, including the orientation of its international economic relations toward the socialist countries.

Since China would then be less interested in interdependencies with the United States, Japan, and its other Asian neighbors, its commitment to a peaceful, stable Asia could be expected to be less. While this drift back toward a more Soviet style of development does not

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[61] Robinson, op. cit., pp. 21 and 47.

[62] Ibid., p. 66.

[63] Ibid., pp. 26 and 69.

[64] Ibid., pp. 64-69.

[65] C.L. Chiou, "Dilemmas in China's Reunification Policy Toward Taiwan," *Asian Survey*, vol. XXVI, No. 4, April 1986, pp. 467-470.

[66] "Dutch 'Close' to Solution on Taiwan Sub Sale," *Xinhua*, Oct. 8, 1986, in *Foreign Broadcast Information Service Daily ReportChina*, Oct. 8, 1986, p. G4.

[67] Robinson, op. cit., p. 45.

Photo credit: Xinhua News Agency

IBM computers and equipment in the Shenzang Air Blower Plant. This computer center is used for plant production management and technical information storage.

seem to be the most probable course for China in the short term, the reasons that might make it attractive are credible and deserve monitoring.

A final factor influencing assessments of China's future direction is the nature of the post-Deng leadership. It has been widely assumed that this leadership would be committed to a continuation of the Dengist policies. Again, however, it is appropriate to be cautious. First, it is by no means clear that there is the leadership unity that the Chinese have tried to project; divisions based upon personality, factional affiliation, policy preference (particularly on issues of reform), and understandings of the political "rules of the game" undoubtedly exist. It is impossible for the outside observer to know whether the forces that unite the leadership are stronger than those that divide it.

Second, many of the new leaders received training in the Soviet Union and may have residual sympathies for it and respect for Soviet (including technological) achievements. More importantly, their careers have been in a system modeled after that of the Soviets. Their most basic understandings of how economies and polities operate derive from this experience.

Many of the new leaders also have backgrounds in engineering disciplines, but received training under conditions where the engineering task is understood in the context of a socialist economy. It is likely that this "socialist engineering" orientation is particularly compatible with technocratic planner orientations rather than market orientations. While such leaders would have a studied appreciation for the sophistication of Western technology, they are unlikely to have an ingrained professional sense of the relationships between Western technological development and the operation of a capitalist market economy.

Furthermore, Chinese technological achievements in such areas as nuclear weapons and space may be taken as indicators of indigenous capabilities that should be further nurtured and protected in the face of the challenge from foreign technology and equipment imports. This type of protectionist view is likely to be found throughout the politically important heavy-industry sector. It is notable that the greatest resistance to domestic economic reform has come from this sector.[68]

The future leaders are unlikely to lead China back toward the radical Maoist experiments of the past. However, by training and experience, many are likely to be more comfortable with a planned system. They are also more likely to prefer policies that protect Chinese industry from foreign competition and penetration rather than a more marketized "open" economy.

Conclusion

U.S. security interests in Asia are in a sense more complicated and less certain than in Europe. Lines of conflict and patterns of threats are less clear-cut, and there is much greater national and cultural diversity.[69]

Nevertheless, certain features of the Asian security scene in the post-Vietnam war era have been consistent. These include the general stability in the region, which has both facilitated and been helped by the remarkable economic growth and development experienced by many of the countries. At the same time, tensions are by no means absent.

The region has seen a significant growth in Soviet power resulting from the increased deployment of military assets in Asia and the strategic advantages the Soviet Union enjoys in Vietnam and North Korea in return for its assistance. In the face of a long-term Soviet commitment to enhance its power and influence in Asia and the Pacific, and U.S. intentions to limit this growth, superpower rivalry in the region will continue for some time and will be the main element structuring the security environment.

The divided-state phenomenon in China and Korea is a second major, persistent, and potentially destabilizing security problem. Korea is a potential flashpoint with global consequences. The Taiwan problem is the main long-term threat to good U.S.-China relations; its management requires restraint and skill from all the parties, but these characteristics are by no means assured. Finally, Vietnamese behavior in Indochina is perceived as a serious direct threat to Thailand, is a source of concern and annoyance to China, and is viewed by the other states of Asia as a possible cause of heightened and unwanted great power competition in the region.

The "China factor" in U.S. interests in Asian security is multifaceted. For some of the states in Asia with which the United States has close relations and strong interests, China is regarded as the chief long-term security problem. This view is heard most often from the states in Southeast Asia and, of course, from the government on Taiwan. From the U.S. point of view, however, China has the potential for serving as part of the solution to the main security problem: growing Soviet power and influence in the region. A China capable of power projection across the Pacific to threaten the United States directly is decades into the future. However, a strong China opposed to Soviet expansion and friendly to the United States, even if following a nominally independent foreign policy, is viewed by the United States as a security asset in that it complicates Soviet strategic planning.

By following its current course, China is less of a security threat to the United States and its friends and allies in the region than it was in the past, when it pursued policies of revolutionary transformation at home and supported revolutionary movements in the Asian region.

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[68] See Susan Shirk, "The Domestic Political Dimensions of China's Foreign Economic Relations," *China and the World: Chinese Foreign Policy in the Post-Mao Era*, Samuei S. Kim (ed.) (Boulder, CO and London: Westview Press, 1984), pp. 57-81; and Bruce Cumings, "The Political Economy of China's Turn Outward," *China and the World: Chinese Foreign Policy in the Post-Mao Era*, Samuel S. Kim (ed.) (Boulder, CO and London: Westview Press, 1984), pp. 235-266.

[69] Richard H. Solomon, "American Defense Planning and Asian Security: Policy Choices for a Time of Transition," in Daniel J. Kaufman, et al., (eds.), U.S. National Security (Lexington, MA: Lexington Books, 1985).

Although China's Asian neighbors have anxieties about China as a security threat, they too appear to be more hopeful that China pursuing its current course will be less of a threat than the China of the past.

Of course, when modernized, China will also be more capable, and thus more of a potential security threat to the countries of the region and to U.S. interests. If China succeeds in its modernization, it will have the economic and military capabilities to be a major disruptive force in the region if it so desires. However, China's pursuit of modernization, through interactions with the world economy and by promoting peace and stability in the region, is in the security interests of the United States and its friends in the region.

The policy choices faced by the United States and its friends and allies in the region are therefore challenging. Policies to retard Chinese modernization—for instance by denying access to technology, capital, and markets—out of fear of potential hostility are likely to be self-defeating. It appears that Chinese hopes for modernization have been one of the prime causes of China's becoming a more constructive member of the international community.

Chapter 8

U.S. Policy Choices

Photo credit: Eric Basques

A fisherman on the Li River near Guilin looks out over some of the most spectacular scenery in the world

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Chapter 8

U.S. Policy Choices

This chapter analyzes what the U.S. Government, and Congress in particular, might do to maximize the gains and minimize the risks associated with transferring technology to China. The first part examines major themes in current U.S. policies affecting technology transfer to China, highlighting areas where new initiatives may be needed to achieve policy goals.[1] Specific issues that Congress and the executive branch may want to address, regardless of overall directions in China policy, are then addressed. The chapter concludes by identifying actions that Congress may wish to consider.

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[1] See OTA, *Energy Technology Transfer to China—A Technical Memorandum*, OTA-TM-ISC-30 (Washington, DC: Government Printing Office, September 1985), for a discussion of the risks and benefits to the U.S. national security of transferring energy technologies, and for a review of pending issues in U.S. policies affecting control and promotion of technology transfers.

THEMES IN U.S. POLICY

Since the United States and China formally resumed diplomatic relations in 1979, interactions have expanded on a number of fronts. As China moved gradually to relax restrictions on foreign business and open the door to Western participation, the United States has loosened restrictions on exports to China and widened the scope of science and technology (S&T) exchanges.[2] The United States and China have begun to consult on issues such as Afghanistan and Indochina and to explore other possibilities for strategic cooperation.[3] Defense delegations are exchanging visits and foreign military sales (FMS) have begun.

The decisions that ushered in these new developments in U.S.-China relations are based on a rationale, shared by four U.S. administrations, that assisting in China's modernization will serve U.S. interests. Exchanges of goods, people, and ideas present commercial opportunities for U.S. business, provide mutually enriching cultural exchanges, and could help integrate China into the world economy and make it less vulnerable to outside pressures.[4] Official U.S. policy statements have stressed that China is a friendly, but not an allied, country—one particularly important because of its large population and potential role as a counterweight to the Soviet Union. If China's modernization succeeds, it will be a candidate for superpower status in the future and, at the least, an important regional power.[5]

Many view these assessments as sound calculations of U.S. national interest. A number of developments indicate progress in achieving some policy goals. China is experimenting with economic reforms that involve expanded Western participation in trade and joint ventures, and has expressed desire to participate in multilateral organizations such as the General Agreement on Tariffs and Trade (GATT). Among the ranks of China's leaders are many who have been trained in the West. China has developed an "independent" foreign policy, avoiding close ties with the Soviet Union.

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[2] One authoritative estimate is that between 1979 and 1983 about 19,000 Chinese students and scholars came to the United States. See Leo A. Orleans, "Chinese Students and Technology Transfer," *Journal of Northeast Asian Studies*, vol. iv, No. 4, winter 1985.

[3] See Harry Harding, concerning reports of a joint U.S.-Chinese effort to monitor Soviet tests in "China's Changing Roles in the Contemporary World," in Harding, *China's Foreign Relations in the 1980s* (New Haven, CT: Yale University Press, 1984), p. 194.

[4] See statements by U.S. Ambassador Winston Lord, quoted in *International Trade Reporter*, June 4, 1986, p. 752.

[5] See Jonathan Pollack for an argument that China "...enjoys the privileges and deference conceded a major power, without possessing the requisite national capabilities and accomplishments that appear to define the term." Pollack, "China and the Global Strategic Balance," in Harding, op. cit., p. 170.

Some observers, however, worry about what they see as an emotional and overly optimistic strain in U.S. policies toward China.[6] The United States and China have quite different political and economic systems. While they share mutual interests in some areas, they disagree in others. The primary strategic concern is that China might use the technology supplied by the United States in ways that run counter to U.S. interests or to those of other Asian countries friendly to the United States. A second area of concern is commercial. U.S. businesses still see potential in China's domestic market, but also view China's export and performance requirements[7] and other regulations of foreign business as obstacles. Over the longer term, China may join the ranks of the Asian newly industrializing countries (NICs) that today loom as major competitors to a number of U.S. industries.

These issues were analyzed in chapters 6 and 7. The general conclusions drawn there were that despite improvements in Sino-Soviet relations, there are reasons to assume that China will in the next 10-15 years see its interests become closer to those of the United States. So long as economic modernization remains China's top priority, China is likely to play a stabilizing role in East Asian security. While institutional and other factors suggest caution in comparing China with the NICs, Chinese exports are likely to grow faster than the overall rate of economic growth. As a result, Chinese exports (representing about 4.4 percent of world exports by 2000) will compete most directly with those of NICs in third-country markets. OTA also notes the many uncertainties about China's future course and the room for disagreement about implications for the United States and neighboring countries in Asia.

Given these uncertainties and a limited 8 years of recent experience, it is not surprising that a number of different themes run through public discussions of U.S.-China policies. The predominant theme, and the one central to current U.S. policy, favors a flexible approach oriented toward gradual liberalization of controls on technology transfers. Other themes, discussed below, also appear in discussions of U.S.-China policy. Each reflects different evaluations of how technology can be used as a tool of U.S. foreign policy.

A Flexible Approach to Liberalized Controls

Since 1983, regulations governing exports have been significantly loosened, consistent with a broad policy direction favoring expanded economic interaction. At the same time, exports of military equipment and very advanced technology are restricted by U.S. export controls. The export licensing system provides mechanisms for revising controls in light of changes in technology and bilateral relations.

Student and technical exchanges have thrived under this flexible approach to technology transfer. These growing exchanges, which do not rely on strong government coordination, have been built at the individual and institutional levels, providing ongoing scholarly relationships, cultural exchanges, and potential commercial opportunities for U.S. firms and organizations. Localities and regions are establishing relationships with their counterparts in China, who are apparently attracted by U.S. educational and research strengths.

The U.S. Government has not taken a strong, active role in coordinating and initiating efforts to expand trade and technology transfer.[8] Official export financing through the Export-Import (ExIm)Bank is comparatively limited, and the United States has no traditional aid program for China. The U.S. Government has instead focused its efforts in trade policy on negotiating agreements that set out the "rules of the game" for trade and investment. In addition, guarantees have been provided for investments by the Overseas Private Investment Corporation, and financing has been provided for low-budget, "reimbursible" feasibility studies, such as those carried out by the Trade and Development Program.

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[6] See Michael H. Hunt, "Chinese Foreign Relations in Historical Perspective," in Harding, op. cit., p. 41.

[7] Examples are requirements that products produced in China include certain amounts of locally produced inputs or that production facilities in China export a certain percentage of output.

[8] The U.S. Government took a stronger lead in the early years through establishment of protocols for industrial and technical cooperation. Many of these efforts continue, as does the Foreign Commerical Service (FCS). In general, however, the U.S. Government has played a facilitating role (outside the export control area) rather than an activist coordination role.

Major resources of the U.S. Government have been devoted to establishing a system of controls on exports to China. The Department of Commerce (DOC) is the lead agency, but the Department of Defense (DoD) and other agencies also participate. Within the general guidelines established, however, technical license examiners actually make many key decisions about exports of sensitive technologies. These choices are critical to the determination of whether a specific technology export takes place. Within the guidelines set by higher level policy officials there is thus room for de facto policy making below as case-by-case decisions are made on whether to export the more militarily sensitive technologies and equipment.

Delays in export licensing review have been a primary source of complaints. Congress has attempted to deal with this problem by requiring the U.S. Government to process licenses within certain time limits. License reviewers may make safe but too rigid interpretations. Lacking understanding of overall policy goals, mid-level and lower level bureaucrats may inadvertently or intentionally work at cross-purposes to overall policy goals. Technology is changing so rapidly that the U.S. Government has found it difficult to revise regulations before large backlogs of pending cases have developed.

A related issue pertains to uncertainty about where the U.S. Government will draw the line to prohibit an export. While export regulations specify the kinds of exports that "are likely to be approved," it is not clear what types of exports will be denied. Applications involving sensitive technologies and equipment (including those for military exports) are decided on a case-by-case basis. Because of this situation and in response to pressure from Chinese buyers to supply more advanced technologies, U.S. exporters are constantly "testing" the parameters of the export control system. Recent experience indicates that incremental decisions do not result in effective and consistent policy implementation.

No single entity of the U.S. Government effectively integrates these diverse efforts into a carefully coordinated program for technology transfer to China. DOC implements controls on dual-use exports, carried out by the Assistant Secretary for Trade Administration. Other parts of DOC such as Foreign Commercial Service (FCS) are involved in trade development programs. Generally speaking, promotional programs are carried out on different policy tracks and by different individuals than those who administer export controls. Within the Pentagon, for example, those charged with "security assistance" are expanding military cooperation, while those responsible for strategic trade are controlling exports.[9]

A pending question is whether it is necessary to formulate and implement a clearer strategy on technology transfer to China. There are few such examples of comprehensive U.S. foreign policy strategies other than for the Soviet Union, where serious problems are apparent. But it may be that the United States has not realized all the potential benefits of a flexible approach. There may be gains to be made from better integrating U.S. programs toward China. The key question is whether this is desirable or possible in view of the many other important foreign policy issues on the agenda.

Activist Strategy of Technological Cooperation

Some favor a more coherent and aggressive strategy of promoting cooperation with China because of China's critical strategic position and commercial promise or because they wish to assist China in its development. Placing special emphasis on U.S.-China relations is a resonant historical theme. For generations, Americans have believed that China is in some sense "special."

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[9] The Defense Technology Security Agency (DTSA) within DoD handles DoD review of both dual-use and munitions exports. DSTA officials attempt to coordinate these policies.

A more activist strategy would probably require a larger role for the U.S. Government. Expanded export financing and FCS representation are possible avenues, as is the establishment of an aid program. Over time, export controls would be diminished, or even eliminated in some areas. Assuming that China demonstrates its commitment to avoiding illegal acquisition and retransfers of Western technologies and that relations improve, the Coordinating Committee for Multilateral Export Controls (COCOM) might decide to end all multilateral export controls for China trade.

Adopting a more positive strategy could help U.S. firms to expand their exports to China and serve to broaden and deepen technology transfer. However, because of China's clearly articulated call for U.S. technology, it would be difficult to develop a promotional policy oriented solely toward expanding U.S. exports of finished products.

A stronger China would be in a better position to counter the Soviet Union, and a successfully modernizing China may serve as a model to Soviet bloc countries. More speculative is the question of whether under such circumstances China would be inclined to contribute constructively to resolving persisting regional conflicts like the one on the Korean peninsula.

By promoting technology transfer to China more actively, the United States could also support expanded free trade in the Asian region. A central question, however, is whether the United States would be willing to eschew protectionist responses to China's growing export capacity. To the extent that a more activist promotional policy implies technology transfer as well as trade, a growing Chinese export capability is to be expected. An activist strategy therefore would involve keeping markets open to Chinese imports. To deal effectively with associated trade impacts, it would be necessary to develop a U.S. strategy toward Asian markets, one that locates China in a broader regional context.

The implications of an activist approach would depend to some extent on the degree to which the strategy were directed to security cooperation. A rapid expansion of military cooperation could create anxieties among Asian countries fearing a U.S.-China alliance. If the ultimate goal of U.S. foreign policy is to preserve a stable and peaceful Asia, it may be well to note the limitations of building "special relationships," such as those apparent in the Middle East, where a regional peace remains elusive despite active promotion of relations with a few key countries. If security cooperation with China were pursued unskillfully, it could be perceived as diverting attention away from the NATO alliance and Europe.

There is also a risk that a more activist approach could strengthen certain elements within China, such as parts of the military, or lead to anti-Western backlash stemming from long-held fears that China might become too dependent on foreign suppliers. Under worse conditions, the United States would come to regret an activist strategy of promoting technology transfer if China's leaders switched to an alliance with the Soviet Union.

Technology Leverage

Some advocate the use of technology as a bargaining chip in U.S.-China relations. Underlying this theme is a concern that technology transfer may too often be a one-way street, with U.S. firms providing more and more critical technology while Chinese foreign policy sometimes runs counter to that of the United States. China's stress on nonalignment and its association with Third World issues inferred from United Nations votes are often cited as evidence. According to this view, the United States must extract political concessions for the advanced technology it supplies China.[10] Noting that Chinese leaders are skilled negotiators who never lose sight of national interests in technology exchange, proponents believe that the United States should likewise do more to foster its own foreign policy goals.

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[10] Denis Simon, "China: Too Much Technology Too Fast?" *Technology Review*, 1985.

In contrast to those who believe that expanded technology transfer can help usher in good political relations, those who stress technology leverage believe that transfers should be conditioned on political or other concessions by China.

Technology leverage holds some attractions as a policy theme. Theoretically, at least, China might be further persuaded to cooperate with the United States on Korea or refrain from acerbic criticism of U.S. policy in the Third World in exchange for advanced technologies. Sharing intelligence about Soviet activities could be expanded in the context of transfers of critical technologies. If advanced technology transfers (such as those promoted under the aegis of government-to-government protocols) were linked to requests for broader access by U.S. technical personnel to China's corresponding industrial and research institutions, the United States could gain more from such exchanges. At issue is whether the United States can use transfers of technology to influence China's foreign policy.

Much depends on the way in which bargains are struck—through publicly applied pressure or in closed-door sessions—and the extent to which quid pro quo exchanges would be expected. Public demands for Chinese political concessions in early stages of negotiations could easily backfire. Nor does it appear likely that other Asian countries such as Japan would be willing to participate in pressuring China to change its policy vis-à-vis Taiwan, for example. Chinese resentment over the bargain struck by Moscow in economic cooperation with China in the 1950s suggests the possible liabilities of such an approach.[11] Nor is it safe to assume that Chinese leaders simply respond to U.S. actions, ignoring the importance of history, traditions, and domestic political pressures. The application of pressure (in the form of conditions set on technology transfers) will not necessarily result in the response desired.

Technology leverage may work in some precedent-setting cases, where negotiations are conducted behind closed doors. In such instances, however, it may be difficult for all but the few directly involved to understand the linkages between technology transfer and politics. Sensitive issues such as cooperation in intelligence gathering fall into this category. In view of the many routine decisions made in export licensing, it hardly seems possible that explicit bilateral political deals could be struck in any but a few key cases. On the other hand, conditions in many cases have been set on transfers of advanced technologies to China. The Chinese have apparently judged these limitations on their use of U.S. equipment and technology as not desirable but acceptable. The end-user certification provided by the Chinese government to verify the Chinese buyer of Western technology, for example, addresses Western concern about retransfers to the Soviet bloc.

Another factor limiting stronger emphasis on technology leverage is the wide availability of many advanced dual-use and military technologies. Because China could always turn to other suppliers, a unilateral strategy to deny technology would not be feasible in most cases. But China wants U.S. technology, and transfers from the United States undoubtedly have political value to the current leadership.

Photo credit: Eric Basques

As a diesel locomotive enters the Shanghai railroad station a steam locomotive on a siding is unloaded. The Chinese plan to decrease their reliance on steam locomotives and will promote railroad electrification.

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[11] Stalin demanded access to Chinese port facilities and the formation of joint stock companies, and insisted that China pay for all economic and military assistance. See Harding, in Harding, op. cit., p. 183. Some experts, however, believe that the Soviet Union was actually much more generous in its economic cooperation with China. In any case, such negative Chinese *perceptions* could color economic cooperation with other countries.

If stress is laid on U.S. willingness to supply (rather than threaten to deny) certain kinds of advanced technologies, it may be more likely that political understandings can be developed in conjunction with these transfers. Even if technology is seen more as a carrot than a stick, however, U.S. Government influence is limited in the sense that private companies make independent judgments about potential gains and risks. It appears that technology leverage will have to be applied selectively, and that it may be most effective in the context of a flexible approach.

A Cautious Approach to Technology Transfer

Still another theme in debates over U.S. technology transfer policy is one of caution. Because China may well have trouble in assimilating the most advanced technologies, some prefer to concentrate on transfers of less sophisticated technologies. Others may hope to avoid the "boomerang" effect—providing China with the technology to transform itself into a major competitor. Those who see the China market as a chimera, and those wary of close relations with a Communist country where leadership changes have in the past resulted in swings in policy, would prefer to proceed slowly in technology transfer to China.

Much would depend, however, on whether caution is directed at slowing the pace of U.S. export control liberalization, or adding new restrictions that negate the liberalization that has already occurred. Assuming no great adverse developments in bilateral relations, it seems unlikely that the United States would abruptly reverse the current policy path. On the other hand, if relations were to sour, a more cautious policy would be a natural outgrowth.

Despite the apparent safety of exercising caution, there are significant liabilities. In the current context of U.S.-China relations, officially stressing this theme would very likely antagonize China, perhaps pushing the Chinese toward rapprochement with the Soviet Union. The United States cannot prevent China's economic modernization or preclude China's emergence as an exporter. Nor is the U.S. Government well equipped to further such goals systematically through technology transfer policies.

Those who favor caution on the grounds that certain types of technology transfer are not appropriate for China must recognize the limits on the ability of the U. S. Government to tell China how to carry out its modernization programs.[12] Where U.S. Government financing or sponsorship are provided, as with the Trade and Development Program (TDP) and Overseas Private Investment Corporation (OPIC) projects or those receiving ExIm financing, the Federal Government has leverage in selection and in setting requirements that ensure effective technology transfers. Particularly in the case of officially sponsored cooperation projects (under the protocols), there is considerable leeway for shaping the projects to ensure protection of public health and safety. But such projects are only a small part of U.S.-China trade. Generally speaking, U.S. Government influence had been focused on ensuring that the risks to national security are minimized.

It must also be noted that China could pose a major security risk if it fails to achieve its development goals. A stagnant Chinese economy could breed political disaffection at home and conceivably a foreign policy less open to the West and more threatening to other countries in Asia.

A Multilateral Approach

A multilateral approach to China has not been strongly emphasized. Such an approach implies that the United States, Japan, and Western Europe share common interests in assisting China's economic modernization and integration into the global trading system while protecting Western security through controls on militarily significant exports that could be useful to the Soviet Union or other adversaries.

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[12] For a discussion of U.S. government influence on China's selection of energy development projects, see OTA, op. cit., pp. 58-59.

Major Western suppliers of technology to China thus have joint interests in ensuring that all compete fairly for the China market and in preventing the diversion of advanced dual-use technologies to adversaries. COCOM and the Organization for Economic Cooperation and Development (OECD) agreements on financing reflect these joint interests. Taking a broader view of commercial interests, if some countries maintain severe restrictions on imports from China while others take a more open approach, the burdens of domestic adjustment will be unevenly spread and resentment may grow. From a Western security perspective, a joint approach to export controls is also essential because Japan, Western Europe, and some NICs are now developing dual-use technologies and producing sophisticated equipment and services with military applications.

A multilateral China policy would have many advantages, but there are also problems. Western countries compete for technological leadership and participation in the China market. Although firms from many countries are cooperating in large, capital-intensive projects in China, it is also true that they are vying for prime contractor awards and market shares. The United States thus has significant commercial interests at stake in the export of goods and services that translate into jobs for American workers and revenues to support further innovation and economic growth. Similarly, while a joint approach to export controls is mutually beneficial and essential, different COCOM countries approach export controls differently; thus, firms in different countries face different obstacles to exporting.

The dilemma from a policy perspective is that multilateral agreements are often based on the lowest common denominator—the rules of the game acceptable to the most liberal member of the club. The question is whether, through deliberations over China's entry into the GATT and other multilateral institutions and through OECD negotiations over financing, the scope and strength of agreements can be expanded. OTA's research also highlights the need to strengthen the COCOM system.[13] But, despite the contribution made by COCOM governing certain types of dual-use exports, there are significant differences in policy approaches. The United States maintains unilateral controls on many types of exports to all countries (China included) and makes a serious attempt to limit potential diversions through controls on re-exports. Japan and Western Europe, as discussed in chapter 5, have much less complicated procedures for review of export applications and oppose extraterritorial application of U.S. laws. From a security perspective, the problem is further complicated by a number of NICs in Asia (not members of COCOM) that serve as production sites and entrepôts for high-technology trade.

In theory, the obvious solution is to bring the export control policies and practices of the COCOM countries more into harmony while persuading non-COCOM countries to institute effective controls. Harmonization of COCOM policies implies some modifications by both the United States and other COCOM allies. If for example, the United States were to eliminate unilateral controls on exports to China, U.S. exporters would benefit. Permitting freer intra-COCOM trade might help persuade other COCOM countries to be more vigilant in preventing diversions from third-country markets. Because each country has a different legal and administrative tradition, however, it would be unrealistic to assume that harmonization would eliminate all differences or reassure critics who charge that burdens and benefits are unequal.

Theme Implementation

In practice, the five themes discussed above are played out in U.S. policy. Periodically, U.S. negotiators seek specific assurances from China in return for sensitive technology transfers. A recent, publicized example was China's decision to become a member of the International Atomic Energy Agency and accept safeguards, and public statements that it will not assist other countries in developing nuclear weapons (in the context of negotiations on a nuclear cooperation agreement).[14] In other areas, such as scholarly exchanges, the U.S. Government has taken a more positive approach. In contrast, absence of an aid program indicates a cautious approach.[15] The multilateral theme is reflected in COCOM and trade-related agreements, such as the OECD agreement on financing.

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[13] See also National Academy of Sciences, Report of the Panel on the Impact of National Security Export Controls on International Technology Transfer, *Balancing the National Interest: U.S. National Security Export Controls and Global Economic Competition*, 1987, for detailed recommendations about COCOM.

More important than the policy instruments is the overall direction of U.S. policy. It is, of course, possible that no clear choice will be made to seriously redirect policies. Regardless of whether a decision is made to highlight one of the secondary themes in order to develop a more coherent strategy, there are substantive policy choices that Congress will face.

One set of policy choices concerns *export controls*. Whether the goal is technology leverage or cooperation, delays and inconsistencies in export licensing decisions remain issues of concern. Congress has an important role to play in oversight of U.S. export policy. Indications of problems in the system are the continuing turf battles among agencies, misunderstandings about the policies of other COCOM countries, and the sometimes conflicting technical and policy judgments in determining threshold levels.

Promotional policies supporting expanded trade and technology transfer through financing and other means constitute a second area of policy choice. Will major stress be laid on export promotion, protectionism or bilateral bargaining, and what will the longterm implications be for U.S.-Asia trade? Congress reviews and helps determine programs of the Export-Import Bank, OPIC, TDP and the FCS.

A third area of choice is *military cooperation*. The scope, nature, and mechanisms for miltiary cooperation will be clarified in the years ahead. Congress has an important role to play in reviewing military sales, particularly those involving FMS credits.

Scholarly and technical exchange is another arena for policy choices that affect technology transfer. Congress allocates funds for fellowships and lectureships that support research and study in the United States by Chinese scholars, and study visits to China by Americans.

Congress also reviews overall U.S. foreign policy toward China to assess the success of past policies and to anticipate future problems. Policies toward China reflect perceptions of the global role of the United States. Should the United States pursue a policy of strong engagement in Asian security by building new coalitions and maintaining a large military presence or take a more "minimalist" approach, restricting its efforts to maintaining the alliance with Japan and naval deployments needed for the strategic submarine fleet?[16] Should the primary goal be to build a strong bilateral U.S.-China relationship or to expand multilateral cooperation? Can the United States afford to promote free trade and transfer technology to developing countries without suffering serious losses, or is it necessary to protect U.S. interests through bilateral bargains and trade protectionism? Many of these questions are beyond the scope of OTA's study of technology transfer, yet the answers are critical to this subject.

These substantive issues are discussed more fully in the next section. Detailed examination of issues that Congress may confront, and recent experience with policy implementation in these issue areas, suggests that new initiatives may be needed if the United States is to maximize the potential benefits and minimize the possible risks associated with transferring technology to China.

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[14] See OTA, op. cit. Congressional debate over the nuclear agreement focused on the strength of these assurances, pp. 54-55.

[15] The absence of a formal U.S. aid program can also be interpreted as reflecting judgments that U.S. priorities for assisting China in its modernization should be in other areas, rather than simply a negative view toward aid per se.

[16] See Richard H. Solomon, "American Defense Planning and Asian Security: Policy Choices for a Time of Transition," in Daniel J. Kaufman, et al., *U.S. National Security* (Lexington, MA: Lexington Books, 1985), p. 384.

EXPORT CONTROL POLICY

Export controls have been a continuing point of controversy in U.S. policy debates over technology transfer. At the heart of these debates is the problem of balancing the twin U.S. policy objectives of promoting international trade and protecting national security. Criticisms of U.S. controls on exports to China have been raised by U.S. exporters eager to expand trade, Chinese officials desirous of more advanced technology, and officials and businessmen in other COCOM[17] countries who see some kinds of U.S. export regulations as infringing on their own sovereignty. DoD has been the target of much of this criticism, primarily because some believe that DoD interprets export regulations too stringently, causing commercial loss to U.S. firms. Observers also question whether U.S. controls concentrate sufficiently on slowing the flow of technologies with real military significance. Congress plays a critical role in framing the legal basis for export controls and in its oversight of the system.

These are general issues not specific to China. But they have been a central focus of debates over U.S.-China policy because extensive controls on exports to China were maintained throughout most of the postwar period and because those controls have been adjusted in recent years to reflect an improving bilateral relationship.[18] China licensing has been a concern more specifically because the United States expected loosened controls to facilitate trade with China and because the number of China licenses reviewed by the U.S. Goverment and by COCOM grew rapidly in the 1980s. In 1981, for example, the Reagan administration decided to treat exports to China favorably at technological levels twice those permitted for the Soviet Union. While the meaning of the "two times" rule remained less than clear, it signaled a liberalization in U.S. policy, as did the 1983 announcement that China would be moved to country group "V" for export control purposes.[19] A zone system was developed for China exports, resulting in faster reviews for items in the "green zone." (See discussion of these zones in ch. 7.)

The most recent significant step in the direction of liberalization was taken in late 1985, when COCOM member countries revised regulations governing exports to China. These changes, as published in revisions of the Advisory Notes to U.S. export regulations, were to result in a ". . . substantial decrease in processing times" for exports to China.[20] This was to be accomplished by expanding the range of exports likely to be approved for export and by eliminating the need for their review by COCOM and U.S. agencies outside DOC. Green zone commodities can now be re-exported to China from COCOM member countries under licenses issued by those countries. Likewise, DOC and other agencies involved in export administration have attempted to improve the efficiency of the U.S. licensing process.[21]

From the exporter's point of view, a key question is whether an individual validated license (IVL) is required. Most exports involving technology require an IVL. If the application is for a commodity that falls within the green zone, license review is normally conducted only by DOC and can be completed in a few weeks. Otherwise, more extensive review

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[17] COCOM (the Coordinating Committee for Multilateral Export Controls) is an informal organization based in Paris. The member countries include NATO countries (minus Iceland) and Japan. The purpose of the organization is to control exports of militarily significant items to the Soviet bloc.

[18] For an overview of U.S. export controls (and promotional policies) affecting technology transfer to China, see OTA, op. cit., especially ch. 5.

[19] The V country group includes a large number of countries—Britain, France, Yugoslavia, India, Syria, and Iran among them. It should be noted that U.S. regulations on exports differ across these countries. The V country group is really a catch-all category; export regulations are not uniform for all of the countries in this category. China is, however, the only country in this group subject to COCOM review and national security controls.

[20] See Department of Commerce, ITA, 15 CRFT Parts 373, 374, 375, 379 and 399, "Exports to the People's Republic of China: Amendments to the Export Administration Regulations," *Federal Register*, Dec. 27, 1985, 52900.

[21] See Paul Freedenberg, Assistant Secretary of Commerce for Trade Administration, before House Foreign Affairs Committee, Subcommittee on International Trade and Economic Policy, Apr. 17, 1986, pp. 4-5. DOC made special efforts to reduce case processing time for exports to China by establishing a special "China team center" in 1985.

Table 17.—China Export Licenses—1984, 1985, and 1986

Commodity Control List (CCL) Category	Dollars approved (thousands) 1984	1985	1986
1091 Numerically controlled equipment	4,019	13,770	9,361
1312 Presses for ceramic manufacturing	14	0	0
1353 Communication cable manufacturing equipment			6,985
1354 Integrated circuit manufacturing and testing equipment	115	5,422	1,971
1355 Electronic device manufacturing equipment	23,304	94,527	74,311
1358 High technique memory/switching device testing and manufacturing equipment	168	7,316	3,463
1359 Tooling for fiber optic manufacturing	0	0	0
1391 Robots and electronic controllers	0	0	0
1460 Nonmilitary aircraft, helicopters	164,006	1,025,385	117,126
1510 Underwater detection equipment	1,148	2,017	578
1519 Single and multichannel transmission equipment	11,568	3,007	1,965
1520 Radio relay equipment	1,626	69,224	4,347
1522 Lasers and laser systems	1,501	6,820	6,729
1529 Electronic measuring, calibration, and testing equipment	11,899	33,144	34,118
1531 Frequency synthesizers and equipment containing	2,989	35,241	11,004
1533 Radio spectrum analyzers	2,188	3,036	4,811
1537 Microwave equipment	627	2,457	1,696
1555 Electronic video tubes, components	31	1,263	199
1564 Integrated circuit and electronic assemblies	15,727	38,009	12,313
1565 Computing equipment	1,164,339	3,897,369	2,694,130
1566 Computer software	[a]	3,713	4,835
1567 Communication switching, stored program	0	14,300	52,517
1568 Electric/electronics equipment	699	1,013	495
1572 Recording, reproducing equipment	57,738	66,089	52,339
1584 Oscilloscopes	1,866	3,183	2,336
1587 Quartz crystals/assemblies	67	11	1
1767 Optical fiber preforms	0	0	0
Total for 27 CCLs	1,465,639	5,322,603	3,092,795
Total all CCLs	2,004,199	5,493,456	3,366,460
27 CCLs as % Total CCLs	73.1	96.8	91.8

NOTE: Temporary licenses are excluded. Data include total for calendar years in current dollar value for IVL applications.
[a]Included in 1565.

SOURCE: U.S. Department of Commerce.

is required by other U.S. Government agencies and by COCOM. In early 1986 this green-zone review was extended to cover certain kinds of items covered by 27 Commodity Control List (CCL) categories as shown in table 17.[22]

The number and value of U.S. licenses approved for exports to China has expanded rapidly in recent years. The dollar value grew by 15 times, from $374.3 million in 1980 to $5,493 million in 1985, though it declined to $3,366 in 1986. The number of applications more than doubled between 1983 and 1985, rising from 4,300 to 10,200. In 1986, a total of 8,130 cases (including temporary licenses) were closed out for export to China.

Not surprisingly, the bulk of the approved IVLs fall into a few commodity groupings. In 1980, more than 60 percent (in dollar value) of the approved licenses were for exports of semiconductor manufacturing equipment. In 1986, approvals for exports of electronic computing equipment made up more than 80 percent of the total, and nonmilitary aircraft and helicopters another 7.3 percent in terms of value.[23] Table 17 provides an indication of the prominence of license approvals in the 27 CCL categories liberalized.

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[22] Those include numerical control equipment and software, presses and specialized controls, communication cable machinery, printed circuit board machinery, semiconductor manufacturing equipment, test equipment for recording media, tooling for fiber optic connectors, robots, aircraft and helicopters, underwater detection/locating equipment, data communications equipment, radio relay equipment, lasers, electronic measuring equipment, frequency synthesizers, spectrum analyzers, microwave equipment, image intensifier and TV video tubes, integrated circuits, computers and computer software, telecommunications equipment, A/D and D/A converters, recording and reproducing equipment, oscilloscopes, crystal oscillators, and optical fiber preforms. It should be noted that some but *not* all of the items covered by each of the 27 categories now receive favorable treatment as green-zone cases in license review

Export controls are established to protect U.S. national security by making it more difficult for adversaries in the Soviet bloc to obtain militarily significant technologies. Controversies continue about whether the commercial loss is justified by the national security gains, both values difficult to capture in dollar estimates.[24] Estimating the dollar value of such commercial losses would entail documenting sales won by foreign competitors *because* of delays in U.S. licensing or unilateral U.S. controls.[25] A full estimate would also have to take into account the potential business lost because export controls caused U.S. exporters to forego business or because delays in the U.S. process caused potential buyers to modify contracts.[26] Calculating the dollar value of licenses under review for a long time provides one indicator of the potential magnitude of the problem, however. In January 1987, for example, the total value of licenses pending more than 60 days for export to China was more than $806 million.[27]

U.S. export controls today affect trade with China primarily in a few key advanced technology sectors. Computers, telecommunications, aircraft, precision instruments, and advanced manufacturing equipment constitute the bulk of this group. In most cases foreign firms can supply equivalent technologies. *In 1985, U.S. exports from these sectors made up between one-quarter and one-third of total U.S. exports to China in dollar value.* It is also important to note that these have been key areas of export growth in recent months. From 1984 to 1985, exports of telecommunications equipment, for example, increased by 72 percent and exports of computers and office machines increased by 85 percent.[28] U.S. controls strongly affect joint ventures in China because exports of technical data and advanced manufacturing equipment are often involved, exports that require interagency review. Since these are likely to remain priority import areas for China, controls will continue to affect U.S. exports of advanced technologies. Controls are not a determining factor across the board in U.S. trade with China, however.

The License Review Process

The Export Administration Act, the foundation for the export control system, designates DOC as the lead agency in implementing controls on dual-use exports.[29] The law states that restrictions on international commerce should be used only where necessary to further U.S. national security and foreign policy goals. Section 10 of the act establishes procedures for efficient processing of applications within certain time periods and requirements for periodic reports to Congress. While some critics have charged that Congress should not micromanage export administrators by requiring DOC to process applications within certain time periods, it appears that these stipulations have prompted improvements in license review.

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[23] Data on licensed exports to China are published in the *Export Administration Annual Report*, U.S. Department of Commerce, 1986.

[24] Estimates can be more easily developed for commercial impacts of trade embargoes. See, for example, Gary Clyde Hufbauer and Jeffrey J. Schott, *Economic Sanctions in Support of Foreign Policy Goals*, IIE, October 1984. Developing a quantitative estimate of the national security gains associated with export controls would also be extremely difficult.

[25] As discussed in ch. 4 (supplier country policies), complaints about unfair trading by foreign competitors abound. The American Electronics Association (AEA) has compiled a compendium of examples of export control problems, based on information provided by member firms. Included are reports of delays, unilateral U.S. regulations governing demonstration licenses, and semiconductor manufacturing equipment exports to China. See Case Study Report, AEA, Export Control Task Force, Mar. 12, 1987.

[26] See William F. Finan, "Estimate of Direct Economic Costs Associated With U.S. National Security Controls," app. D, in National Academy of Sciences, *Balancing the National Interst: U.S. National Security Export Controls and Global Economic Competition* (Washington, DC: National Academy of Sciences, 1987). The author estimates that the direct, short-run economic costs to the U.S. economy associated with export controls was $9.3 billion in 1985, and that the overall aggregate impact on the U.S. economy was $17.1 billion.

[27] OTA was given special access to DOC export licensing data, based on a "national interest" finding by the Assistant Secretary of Commerce for Trade Administration. In August 1986, 878 China cases had been in the system for more than 60 days. In January 1987 the number was 809.

[28] DOC official export statistics. It is not clear whether exports in these sectors might have increased even more rapidly without factors relating to U.S. export controls.

[29] The Export Administration Act of 1979, as amended in 1981 and 1985. A copy of the law can be found in the Export Administration Regulations.

All applications for dual-use exports are received first by DOC, which must complete initial screening within 10 days. Cases that fall within the green zone can be approved by DOC alone. Others may be referred to other agencies such as the Departments of Defense, State, and Energy, depending on the particulars of the case. Many, but not all, of such referred cases must also be sent to COCOM for multilateral review.[30] Congress has set time requirements for processing at each stage of the review process to ensure that delays are minimized.[31]

DOC and other agencies have taken a number of steps during recent years to reduce delays. For a period in 1985 a China team center was established. Automation has also been used to reduce the paperwork and time needed to submit a case for COCOM review, to cite another example.

The reorganization of DOC's licensing procedures in November 1985 abolished the China team center set up to speed review of China cases. China applications are now routed to one of four commodity teams that handle individual validated licenses: capital goods (which also handles technical data); computer systems; microcomputers and telecommunications; electronic components, and instrumentation. These teams process applications for exports to China along with similar types of exports to other countries. During the first 6 months after the reorganization was announced, many people were moved to new positions. Problems of adjustment, presumably temporary, became apparent as license reviewers and managers learned new jobs.

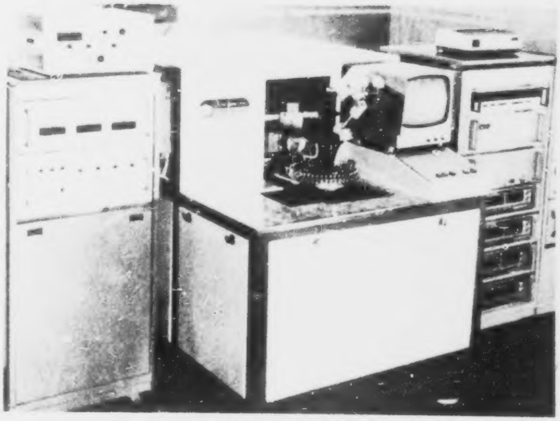

Photo credit: Electro Scientific Industries, Inc.

A semiconductor processing system incorporating a sophisticated laser. This system, including the laser, was built in China.

Management challenges of other kinds (recruiting and keeping qualified personnel and utilizing them effectively) also importantly affect the functioning of the system. Licensing officers and engineering specialists are ranked at GS-9 through GS-13 levels. DOC has apparently lost some its best young people to industry and to DoD. The Office of Export Licensing (OEL) now has a staff of 152 and the Office of Technical and Policy Analysis (OTPA) over 76, but DOC has been unable to fill all of the positions that were open.[32] Expanded use of the automated system for data entry, case tracking, and review may permit a concentration of staff for focusing on really important cases.

Another major goal of the reoganization was to better integrate technical and policy analysis in the licensing process, a persisting issue in U.S. export administration. OTPA was set up in part to improve technical review in precedent-setting cases. However, exporters have found it difficult to understand the division of responsibility between OTPA and the OEL.

There is widespread agreement that automation is a major tool for improving the system.

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[30] The State Department is the lead agency on COCOM and for munitions exports, as discussed in the next section of this chapter.

[31] DOC categorizes cases that exceed statutory limits in a number of categories: 1) applications not requiring interagency referral for which DOC has neither issued nor denied a license within 60 calendar days of receipt (Sec. 10 (c) of the Export Administration Act); 2) applications requiring interagency referral but which have neither been closed out nor referred to COCOM within 120 days after receipt (Sec. 10 (f)(l)); and 3) applications referred to COCOM that are over 160 days old, or exceeded 160 days before completion (Sec. 10 (h)).

[32] DOC, August 1986.

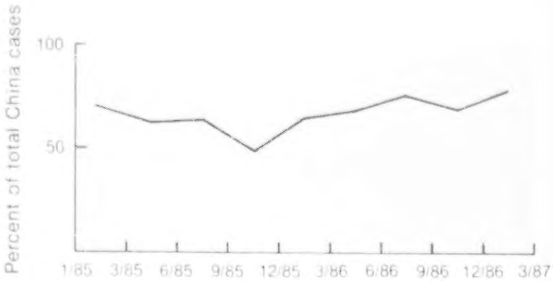
Plans are being made to automate data entry, and a system has been put in place to provide automated response to telephone inquiries about the status of cases.[33] The automated systems can also be used to improve accountability by eliminating some steps in the licensing process. Illustrative of the latter was a striking reduction in the processing times for nonreferred COCOM country cases after license examiners began to use the automated tools available to close out and issue license approvals. DOC has developed a comprehensive plan for automation that in the near term will automate data entry and license issue, and initiate the automation of the license approval process. Over the longer term, the automation plan calls for immediate access by the license examiner to a history of similar cases, online regulations, policies, precedents, and the integration of information about foreign availability.[34]

One near-term objective of DOC is to reduce the time required to complete action on IVLs to 45 days by July 1987.[35] There is no reason why processing times for green-zone cases cannot be further reduced to the time required for free-world destinations (6 days, according to DOC's own goals). *Congress may want to monitor progress carefully toward achieving these goals of quicker license reviews to determine whether additional staff or other resources are required.*

When new China licensing regulations were published in December 1985, the expectation was that, by expanding the numbers of items in the green zone, fewer cases would require interagency referral. However, figure 7 shows that this expectation has been only partially realized. Nonreferred cases were 70 percent of all closed out China cases in both the first quarter of 1985 and the last quarter of 1986, though they rose to 78 percent in the first quarter of 1987.

Figure 7.—Green Zone (Nonreferred) China Cases

(As percent of total China cases closed out)



SOURCE: Office of Technology Assessment, 1987

Average processing time for China cases has declined, a trend that some believe indicates the success of the revised guidelines in streamlining the system. Improvements in processing time also reflect introduction of computerized processing of West-West cases, permitting more efficient use of licensing staff. Table 18 provides an overview of average days of processing time required for all China cases completed during the period January 1985 through April 1987. The number of completed cases de-

Table 18.—Processing Time for China Cases

	Average number of days	
	Number of cases closed	Average processing time
January 1985	911	83
June 1985	976	94
January 1986	786	74
June 1986	609	60
August 1986	666	76
November 1986	514	70
December 1986	411	77
April 1987	729	57

NOTE: Average processing times have been calculated for the cases closed out (completed) during the 30-day period noted. Total cases include referred and nonreferred China cases.

SOURCES: U.S. Department of Commerce, August 1986, January 1987, and May 1987.

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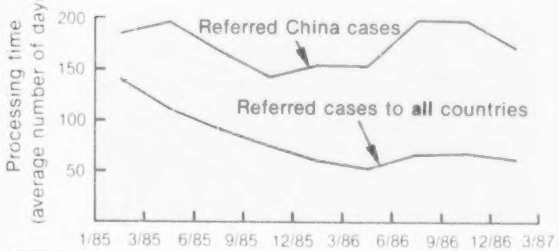
[33] The System for Tracking Export License Applications (STELA) is operational. The system provides exporters with information concerning the location of the case within the system. More substantive inquiries concerning interpretations of regulations are handled by Exporters Assistance and licensing officers.

[34] For a detailed overview of the Export Automated Support System (ECASS) developed by DOC, see Office of Deputy Assistant Secretary for Export Administration, *Export Control Automated System*, July 25, 1986. The plan notes the growing need for interagency coordination, p. 23.

[35] See *Export Control Automated Support System—ECASS*, concept paper, revised, July 25, 1986, p. 12.

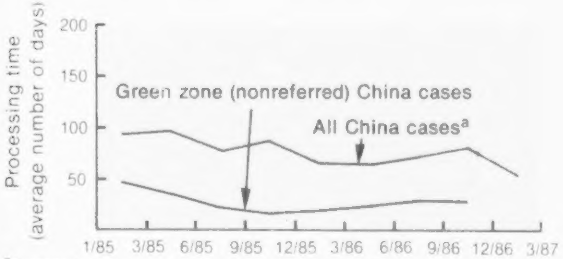
Figure 8.—Processing Time for Referred (Closed Out) Cases



NOTE: Referred cases include those sent to COCOM.

SOURCE: Office of Technology Assessment, 1987.

Figure 9.—Average Processing Times: China Nonreferred and All China Cases



[a]Average for (referred and nonreferred) all China cases.

SOURCE: Office of Technology Assessment, 1987.

clined along with processing times up until mid-summer of 1986; after that, processing times fluctuated, showing another decline in early 1987.

Average processing time for referred cases, however, took more than 200 days in December 1986, and remains significantly higher than processing times for referred cases for export to other countries. Figures 8 and 9 show the persisting pattern of unusually lengthy reviews of referred China cases. During the last quarter of 1986, about 30 percent of the closed out, referred China cases exceeded the statutory limits.[36] *OTA finds that improvements have been achieved in average processing time for China cases but that a significant problem remains in the unusually long periods of review for referred China cases.*

For China exports, and for exports to other countries, the percentage of applications denied is quite small. License examiners can also return applications to the exporter without action (RWA), when additional information is required. Critics have suggested that a large percentage of such applications is cause for concern because the U.S. Goverment may thereby unduly delay or effectively deny an application. The number of RWAs has declined, as table 19 indicates. This reflects efforts on the part of DOC to work with exporters rather than deny or return applications when additional information is needed.

Issue: Is Inter-Agency Review a Major Factor Slowing Review of China Cases Within the U.S. Government?

In December 1986 about 1,300 China applications were pending, and processing times exceeded the statutory limit in 40 percent (524) of those cases. Most of those cases pending over the statutory limit (461 of 524) were referral cases (those sent to other agencies or to COCOM for review).[37] Hence, *the number of China cases pending over statutory limits remained in early 1987 almost as large as it was in the spring of 1986. Cases referred to other agencies make up the bulk of the backlog.* Pending cases for exports to China made up about one-third of the total number of U.S. cases pending over the statutory limits in 1986.

Table 19.—Actions Taken on Closed China Cases

	Percent of total number of cases closed					
	Approved		Denied		Returned without action	
January 1985	70.39%	(83.13)	0.12%	(0.61)	29.48%	(17.24)
January 1986	75.00	(81.86)	0.26	(0.41)	23.73	(17.72)
June 1986	86.77	(88.03)	0.16	(0.16)	13.05	(11.79)
December 1986	89.32	(93.85)	1.21	(0.42)	9.46	(5.72)

NOTE: Percentages in parentheses reflect exports to all parts of the World. Data include temporary exports.

SOURCE: U.S. Department of Commerce, August 1986 and January 1987.

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[36] The percentage of referred China cases where reviews exceed statutory limits was 70 percent in the first quarter of 1985. The percentage of *all* China cases (referred and nonreferred) where reviews exceeded statutory limits was 36.8 percent in the first quarter of 1985 and 16.1 percent in the last quarter of 1986. Data in all cases for closed out cases.

[37] DOC, January 1987. According to DOC officials, cases referred to COCOM normally exceed U.S. statutory limits for review.

In June 1986 the all-agency average processing time for referred China cases was 152 days. At that time it took longer to process such cases than cases for exports to any other part of the world. In early 1987 processing time for referred cases continued at a level of more than 175 days (see figure 8).

OTA analyzed the China cases more than 60 days old, first in August 1986 and then again in January 1987.[38] The number at both times was substantial—more than 800 cases. The total value of these cases actually rose from $713 million in August 1986 to $806 million in January 1987. A significant portion of these cases (134) had been in the system more than one year by January 1987. The value of these cases was $145,342,171.[39]

Most of the cases in the 1987 sample were identified as located in various stages of DOC IVL licensing. (These cases also represented about half of the total dollar value of the pending China licenses.) At the same time, almost 20 percent were in COCOM: they were valued at more than $218 million. The number of cases in the sample located at DoD was not large, and their value was about 5 percent of the total. It should be noted, however, that agencies such as DoD may return cases to DOC quickly, recommending denial or asking for additional information. Cases located in DOC may therefore reflect actions taken by other agencies that have the effect of increasing the period of license review at DOC. For a detailed examination of factors contributing to delays in the interagency review process, see appendix C at the end of this chapter.

The backlog contains a large number of cases that are not really active.[40] Particularly striking were the 50 cases being held without action (HWA) and the 97 cases in which negative consideration letters (NCL) had been sent.[41] Together, these two types of cases were valued at $111 million, or more than 10 percent of the total value of China cases more than 60 days old.

DOC could make a special effort to eliminate cases that have been under review for very long periods of time, thereby making the case list a more accurate representation of cases that are really active. Another possibility would be for Congress to restrict the number of days a case could remain active in the system. For example, cases more than a certain number of days old could be automatically approved unless the Secretary of Commerce provided written explanation to the exporter that the particulars of the case made extended policy review necessary. (Some of these cases would, of course, still require COCOM review.)

It is striking that a few very large companies make up a large percentage of the total value of pending cases. OTA found in both samples, for example, that one company was responsible for more than 10 percent of the dollar value (and more than 15 percent of the total number) of China cases pending more than 60 days. In contrast, another company had only one China case pending for more than 60 days, but it was valued at $2.5 million. This suggests that a few companies take the lead in testing the system and that their efforts are concentrated in a relatively small number of CCL categories, such as computers (CCL 1565). In January 1987 there were 207 cases more than 60 days old in CCL 1565, and 74 of them were valued at $295 million.

It appears that a considerable investment of time and resources is needed to work the system, and few smaller firms can afford to do so. Instead, the export system has nurtured a large group of middlemen and Washington consultants who represent the actual exporters. Measures to make the system more understandable and accessible could make it easier for small U.S. companies to export.

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[38] OTA collected these data samples from the DOC licensing database. The data include the total number of China cases that had been in the system for more than 60 days.

[39] The number of these cases was roughly the same as it had been in August 1986, but the dollar value was substantially higher.

[40] Such cases may be held within the system because the exporter wishes (held with action, or HWA) or in order to fulfill requirements under the Export Administration Act (negative consideration letters).

[41] HWA's are held at exporter's request; therefore, delays in these cases are not caused by DOC. It should also be noted that NCL and intent-to-deny cases routinely exceed statutory limits, due to time periods needed for rebuttal.

Interaction between DOC and DoD has been a major focus of attention in export administration debates. Exporters have charged that DoD dominates the system, interpreting regulations rigidly and delaying decisions. Others, however, question whether DOC green-zone review involves adequate technical analysis.

DoD has reorganized and consolidated its export control apparatus into the Defense Technology Security Administration (DTSA).[42] DTSA reviews the applications for the most sensitive dual-use and munitions exports. DoD has developed its own approach to automation, which builds on the licensing data base that DOC established. During recent months, DoD was processing China cases quickly, on an average of 25 days during the last quarter of 1986, although DoD processing times rose to 31 days in the first quarter of 1987 for closed out cases.[43] DoD has clearly developed a coordinated program for export licensing.

Some fear, however, that DoD is in a position to negotiate unilaterally with exporters, requiring modifications and other conditions on export. Typically more cautious about approving exports, DoD license reviewers are in a position by virtue of their considerable organizational resources to play an important role in reviews of referred cases. There are internal differences within the Pentagon over technology transfer to China, but DTSA plays a leading role in coordination with policy makers in international security affairs.

Exporters sometimes complain that DoD and DOC interpret the regulations differently.[44] While it was beyond the scope of OTA's research to substantiate this charge fully, discussions with officials from both agencies indicated that their views diverge on some key policy issues. Officials in DOC, for example, stress that a de facto red zone exists, while DoD staff disagreed with this characterization, stressing that all cases above the green zone are reviewed on a case-by-case basis. Serious and persisting differences in interpretation of export regulations continue, lending uncertainty to the process and suggesting that policy is not clearly defined or consistently applied.

Problems in reaching interagency consensus have rendered the formal process ineffective. *The formal process is that precedent-setting cases that involve militarily significant exports are referred to various agencies, and the most difficult cases are considered by interagency groups such as the Operating Committee. In practice, however, the Operating Committee formally reviews only a handful of cases.* Higher level formal interagency reviews—for example, those that involve the Secretaries of Defense and Commerce—are also unusual. Without interagency consensus, cases may languish for years with no decision. One solution is for high-level officials in DOC to push for resolution of such controversial cases, bringing them to Cabinet level and even Presidential attention, when necessary.

Some argue that one way to solve the problem of interagency consensus-building is to eliminate DoD participation in license reviews. The committees of jurisdiction in Congress have struggled with this issue in recent years, particularly in the conference committee that reviewed amendments to the 1979 Export Administration Act.[45] Section 10(g) of the act outlines a role for DoD in reviews of cases involving national security. The rationale is that differences in viewpoints among the key agencies (Commerce, Defense, State) involved in export controls can provide useful checks and balances.

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[42] See Defense Technology Security Administration Program Development Plan, *High Technology Export License Review and Analysis System for the 1990s*, May 5, 1986.

[43] For reasons mentioned earlier, the agency average processing times tend to underestimate the overall effect of decisions taken outside DOC that extend review time within DOC.

[44] One example cited was the 16-bit microcomputer. Exporters suggested that DoD first approved such exports, and then began denying them for exports to China. More recently, DoD has once again changed its policy, approving such exports for China. When DoD officials were asked about this and other such examples, they discounted them as inaccurate, suggesting that if 16-bit microcomputer exports were denied for China it was for some reason that had nothing to do with technology level.

[45] The Export Administration Act Amendments of 1985 were eventually signed into law, after prolonged debate in the conference committee.

As the lead agency in export administration, DOC officials have the leeway to present their views more forcefully, if need be, in high-level interagency reviews. Therefore, one alternative is for DOC to play a stronger role. *One way to accomplish this would be to encourage DOC to exercise final authority in approving an application unless DoD exercises its formal appeal to the President as outlined in section 10(g).* Another variant on this would be to amend the act by limiting DoD's role to giving advice to DOC, leaving final authority for China cases with DOC. This approach might be justified by some who see export controls for China as primarily a foreign policy question or by those who favor removing China from COCOM. Still another possibility would be to mandate a deadline for review (such as 6 months) and amend the act to call for automatic approval for cases that exceed the deadline.

The effect of all of these proposals would be to increase incentives for DOC to reach a decision more quickly. Nevertheless, much would depend on how much initiative is taken by officials at DOC. In the first case, the burden of objection would be with DoD, but DOC officials would have to ensure that final decisions were made in timely fashion if the system is to work any differently than it does now. In the second case, national security considerations might be downplayed. Evaluations of that risk, however, depend to some extent on whether or not one judges that such considerations are now overemphasized. Under the third option, there is also a risk that the automatic approval process would produce some bad decisions.

A recent study by the National Academy of Sciences proposes to address these issues by expanding the role of the National Security Council (NSC).[46] NSC currently helps coordinate interagency decision making, and its effectiveness depends to some extent (as with the above options) on the interest and intiative taken by NSC staff. In practice, new and important policy proposals on export controls receive Cabinet-level attention. Encouraging DOC to play a stronger role through one of the mechanisms discussed above, therefore, seems a more direct approach than one that depends on a greatly expanded role for NSC as the interagency arbiter.

Nevertheless, the goal should be to provide new incentives for interagency consensus-building. The process outlined in the Export Administration Act (formal DoD objections conveyed to the President) has not been frequently used, and decisions have been delayed well beyond statutory limits in a significant number of China cases. The question that Congress may wish to address is how to ensure that good decisions are reached in timely fashion.

The Department of State (DOS) is also a key participant in the process, particularly for COCOM cases. Consensus-building among these agencies is difficult because each agency has its own data base, procedures for review, and criteria for making judgment.[47] The Deparment of State, for example, handles foreign cases submitted by other COCOM member countries but does not have ready access to information about U.S. cases involving similar types of equipment and technology.

Issue: How Can Export Regulations Be Clarified To Provide Clearer Guidelines?

Ambiguity in the guidelines for exports (particularly for exports that exceed green-zone criteria) remains a problem. In evaluating this situation, OTA compared the value of approved licenses for exports to China with the value of actual exports. It found that the value of approved licenses for China has not only expanded but exceeds by far the actual value of U.S. exports. In 1980, when U.S. exports to China totaled $3,754 million, the value of export licenses granted was about 10 percent of that total dollar value. In 1985, however, when

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[46] National Academy of Sciences, *Balancing the National Interest: U.S. National Security Export Controls and Global Economic Competition* (Washington, DC: National Academy of Science, 1987), pp. 173-174.

[47] U.S. General Accounting Office (GAO), *Export Licensing: Commerce-Defense Review of Applications to Certain Free World Nations*, GAO/NSIAD-86-169, September 1986.

U.S. exports totaled $3,855 million, the value of approved licenses totaled $5,493 million.[48] Of the 2,688 licenses, valued at $761 million, used for export to the PRC and returned to DOC in 1986, the value of actual shipments was only $483 million.[49]

There are a number of possible explanations for the comparatively large value of approved licenses. First, licensed exports include those for demonstration purposes, where no sale is actually made,[50] and for re-exports of U.S. technology from other countries. However, because licenses for such types of exports were valued at less than $100 million in 1986, these licenses alone cannot account for the comparatively large value of licensed exports.[51] In addition, licenses that are returned without action (because information is inadequate and other reasons) are reentered in the data base when they are resubmitted, and they are double-counted among pending licenses.[52] Also, exporters receiving an approval in one year may make the actual shipment in the following year.

In many cases, however, it appears that final sales never take place, even though a license has been approved. This may occur when a long period elapses between the time of application and the time of approval. In such a case, the buyer may lose interest and turn to another seller.[53] Another explanation is several U.S. exporters submit applications, all hoping to make the same sale in China.

An exporter incurs no penalty for keeping a license active or for making multiple submissions to export similar types of equipment to different Chinese buyers. Exporters may do this to obtain documentation useful in future export licensing submissions. When an application involves cutting-edge technology, industry representatives may also find it necessary to press their cases at high levels.

A certain amount of testing is to be expected, but if this becomes the major mechanism for forcing critical and precedent-setting policy choices, it suggests that exporters (and perhaps license examiners) lack clear guidance and that the policy process has failed. Since the publication of new regulations in December 1985, the green zone has been more clearly defined, but ambiguities remain. Exporters mention areas such as semiconductor manufacturing equipment, software development systems, and computer systems as areas of controversy.

In particular, exporters as well as license examiners are uncertain about how exports exceeding green-zone limits will be treated. Such exports are reviewed on a case-by-case base. In recent years U.S. officials have approved exports exceeding green-zone guidelines, attaching various conditions to export. Powerful computers, for example, have been leased to China for use in seismic applications.[54]

Past China controls included intermediate and red zones along with a green zone. Today, the proscribed "mission areas"[55] provide only general guidelines about what kinds of exports are likely to be denied. In fact, there is no outright prohibition on exports above the green zone; each case is reviewed separately. The absence of a clearly defined red zone provides exporters (as well as Chinese buyers) with incentives to test the system. *Export control regulations provide little guidance to exporters concerning items above green-zone levels. There is no practical way for an exporter to know what previous decisions may have been made to approve exports of certain types unless the exporter is willing and able to invest the considerable resources necessary to learn from officials about such cases or to take the initiative to make multiple applications to document previous decisions.*

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[48] U.S. exports are based on official U.S. statistics.

[49] Data from DOC, April 1987.

[50] Data for 1986 exports included in the paragraph above do not include temporary licenses, however.

[51] Data for re-exports cover the period Jan. 1 to Dec. 31, 1986. U.S. DOC data, August 1986.

[52] A reasonable estimate is that about 10 to 11 percent of the pending cases for export to China are resubmissions. U.S. DOC, August 1986.

[53] A related explanation is that the Chinese buyer finds it impossible to raise the needed foreign exchange to make the final purchase.

[54] Approval of exports may also be conditioned upon the type of end-user, monitoring of facilities and access by Chinese personnel.

[55] See ch. 7 for a discussion of the mission areas.

Photo credit: Wendy Frieman

A consumer electronics factory in Shenzhen. Production has grown rapidly, and exports may soon become competitive with those ~~of the~~ newly industrializing countries.

Publication of a red zone might lead to adverse Chinese reaction and would require continuing modifications as technologies and bilateral relations change. On the other hand, the process of license review might be speeded and coherence in U.S. policy better assured if a more carefully defined red zone could be developed for use within the U.S. Goverment. There is widespread agreement that the U.S. export control system could be improved by concentrating efforts on controlling a small number of truly militarily significant items. Better definition of the red zone would be consistent with this. There is, moreover, the very real danger that review of *all* exports above the green zone level will be slowed unless the red zone can be better defined.

The disadvantages of such an approach would be to reduce the flexibility of the current system and to make it even more important to revise such guidelines in a timely fashion.[56] Some argue that such an approach would be extremely difficult to implement because it would have to take into consideration not only the level of technology and its military significance but also the specific conditions of use, and the nature of the end-user which are generally developed on a case-by-case basis.

For the next few years, the potentially difficult areas of decision for exports to China include powerful computers, electronic measuring equipment, software, telecommunication (including networks and fiber optics), and technical data (including training). *What is lacking is a strategy for future U.S. technology transfers to China in key industry sectors. Practically speaking, sectoral analyses could lay the foundation for expanding the China green zone.* To develop such a strategy, consultations with industry officials would be essential. Moreover, factors such as U.S. commitments to cooperate with China (e.g., under signed protocols), changes in technology, and Chinese technology needs would have to be taken into consideration, along with national security concerns. Developing a strategy for a key industry sector would not be an easy task because many transfers involve technical data and managerial expertise that are much more difficult to bound than equipment and hardware, and because transfers involve combinations of equipment whose technical parameters may be different from the simple sum of the parts. The thrust of the effort would be to chart a future course over a 5-year period, providing exporters and license examiners with better guidelines.

Regardless of the approach taken, *better use of the computerized data base for review of applications for export of equipment or for review of technologies equivalent to what has already been permitted for export could ensure more consistent decisions.* Once a precedent-setting decision has been made to permit an export of a certain type, subsequent decisions should be consistent with those precedents unless other, nontechnical factors come into play. To ensure consistency in decision making, the various U.S. agencies involved in license review would need accurate information about such precedents and common understandings about implementation.[57]

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[56] A major criticism of the current U.S. export control system is that there have been only a handful of findings of foreign availability that provide the basis for removing items from the controlled list.

From a public policy perspective, it may be essential to expand efforts to make the system more transparent. A number of approaches could be considered. *DOC might issue periodic general guidance to exporters about recent key decisions (without disclosing the names of exporters or confidential information).* In recent years the publicly available annual reports on export administration for one calendar year have not been published until many months later. Information about the status of China licensing (numbers of applications approved, denied, and pending in the U.S. Goverment and in COCOM) could be provided to the public on a more frequent and timely basis. DOC has recently taken a step in this direction by setting up an automated telephone system for providing exporters with information about the status of their cases. Efforts to expand automated systems by providing license reviewers with electronic information on precedent-setting cases may also contribute to the increasing consistency in license reviews. Industry participation could also be strengthened through the technical advisory committees (TACs) and specialized seminars for China exporters.

Increased availability of information within the Government and for Congress may also be required. Expanded use of automated systems implies increased accountability for licensing officers and improved information access by policy makers themselves.

The COCOM Review Process

By expanding the COCOM green zone (to permit COCOM countries to process more cases unilaterally), COCOM member countries set out to streamline the review of China cases. Revisions to COCOM China policy made in late 1985 came at U.S. initiative, but they have apparently been well received by other COCOM member countries. The immediate effect of these changes was to relieve pressures on the COCOM organization that had been created by a huge China caseload. *The number of U.S. China cases sent to COCOM declined markedly from 237 in January 1986 to 64 in August 1986. In 1986 the average processing time in COCOM for China cases declined from 77 to 56 days between January and June but rose to 81 days during the first quarter of 1987.*[58] On the other hand, of total China cases closed out on a monthly basis, the percentage of those that had been sent to COCOM actually rose from 13 to 17 percent during the same time period.

The number of U.S. cases pending in COCOM declined in 1986 from 267 in January to 116 in December but rose to 187 in April 1987; the majority of U.S. cases pending in COCOM are for exports to China. Table 20 shows that the number of pending U.S.-China cases in COCOM declined by 57 percent between January and December 1986. Submission to COCOM adds considerable time to the review period.

Issue: Should China Be Removed From COCOM Review?

If relations with China continue to improve and China's economy continues to grow, COCOM policy may require further revamp-

Table 20.—U.S. Cases Pending in COCOM

	China cases	Other cases	Total
January 1986	267	23	308
June 1986	153	34	187
December 1986	116	43	159
January 1987	143	31	174
April 1987	187	63	250

SOURCE: U.S. Department of State

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[57] As mentioned earlier, exports are often permitted with conditions. Disagreements arise as to whether a prior export has established a "precedent," or is more appropriately viewed as a one-time conditional approval.

[58] U.S. DOC, August 1986.

ing. Removing China from COCOM review would have some advantages, would send a positive signal indicating full acceptance of China as a trading partner by the West, and should result in expanded trade in high-technology sectors that now exceed green-zone guidelines. OTA's finding that transfers of dual-use technologies are likely to have limited effects on China's military capability in the near term provides support for removing China from COCOM review.

There is no easy answer to the question of whether the United States would stand to gain in commercial terms if such action were taken. The answer depends in part on whether U.S. exporters are disadvantaged by the current system. *OTA heard widespread complaints from U.S. exporters about loose export controls in other COCOM countries.* However, OTA was unable to substantiate these claims with specific examples in China. U.S. exporters could help clarify this issue by providing hard evidence to the U.S. Goverment. On the other hand, the different approaches of various COCOM countries to publishing China regulations provides one indication of leeway for legitimate differences in the interpretation of guidelines. It is also clear that the United States is the only country that attempts to limit unauthorized re-exports through third countries. But exporters from other countries also complain that the United States has used the export control system to its own commercial advantage, by proceeding to liberalize U.S. policies prior to agreement within COCOM.[59] By far the largest impact of removing China from COCOM would stem from faster review within the U.S. Goverment, rather than from elimination of discrepancies in the policies of other COCOM member governments.

There, however, would be some disadvantages to removing China from COCOM. If China's policies shifted dramatically (for example, toward alliance with the Soviet Union), it could be difficult to persuade COCOM members to return China to COCOM review. Nor would all COCOM members necessarily favor removing China from COCOM at this point, considering the important role that COCOM plays in the review of military as well as dual-use exports and given their different perspectives about East Asian security. Even if COCOM continued to review military exports (while review of dual-use exports were eliminated), some would argue that there is no overwhelming reason why this step should be taken now. Although the COCOM process is opaque and slow, it provides a mechanism for consensus-building on China policies among the member countries.

Some further "harmonization" of COCOM country policies may be essential for the viability of the multilateral control system. As discussed more fully in Chapter 5, no one would expect the COCOM countries to have identical approaches to export control, given their widely diverging political and economic systems. Complaints of wrongdoing indicate deep suspicion by COCOM members about their associates in the multilateral controls system. *A comparison of export control systems in various suppliers is a necessary first step toward further harmonization of approaches. The United States could best pursue this through a joint effort involving other COCOM countries.* The goal would not be to force other countries to change their systems, but rather to understand better where differences lie and determine whether these differences result in weaker controls or just different approaches to controls.

The United States could begin this process by establishing the general principle that COCOM countries should strive to develop uniform controls on exports to China. The United States unilaterally controls some types of exports to *all* countries worldwide. While these controls are not specifically directed toward China, they do represent a divergence in the U.S. approach. Over the long term, the United States may be in a better position to persuade other COCOM countries to strengthen their controls on re-exports if U.S. controls on exports to other COCOM countries are further relaxed.

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[59] It should be noted that the United States continued to submit U.S. cases that required COCOM review to COCOM after the 1983 liberalization of U.S. policies.

One as yet little noticed effect of the revised COCOM China policy may be to bring to public attention discrepancies among COCOM member countries in interpretation. Because the United States and some other COCOM member countries have published their own regulations, based on COCOM policy changes, the technical parameters used in judgments about China exports made in various countries are open to public scrutiny and comparison.[60] If public debates over these questions expand, the need for congressional oversight of the multilateral export control system may be heightened.

What Other Actions Could Be Considered?

During the past 6 years, a series of important, progressive changes have been made in U.S. controls on exports to China. An important issue is whether or not these changes have been paced to maximize U.S. commercial and national security goals, and whether the process of updating the export guidelines can be improved.

Critics suggest that these regulations merely codify the U.S. approach as worked out in practice during the period 1983-85. On the other hand, it is true that the original green zone included only 7 CCL categories, whereas the green zone today was expanded in 1986 to 27 categories (and later to 30). Some observers have expressed concern that the stimulus for new determinations in precedent-setting cases often comes from other COCOM member countries who push harder than the United States for approvals to export; they cite key decisions on sales of telecommunications switching equipment and seismic equipment as examples.

U.S. industry representatives provide their views through the TACs. But the process involves extremely complicated technical reviews, which are not always effective in providing information and analyses used by U.S. exporter adminstrators.

With the liberalization of U.S. controls on exports to China, key decisions on nongreen zone exports have become more difficult. The need to continually update the guidelines will remain. On a multilateral level, COCOM policies will have to be reviewed and the treatment of China considered in light of developments in overall relations with the West. One stimulus for another full review of China policy in the United States and COCOM would be the buildup of another backlog of U.S. cases in COCOM. *If, on the other hand, the U.S. Goverment were to adopt today a more active lead in reducing the COCOM list for China when the equipment and technologies are no longer state-of-the-art or when they are widely available in China, a more measured and anticipatory approach could be developed.* These efforts, if pursued positively, could expand and deepen consensus among COCOM member countries about technology transfer to China.

DOC has recently proposed that distribution licenses be made available for China, a change that would require legislative action. Such licenses make it possible for U.S. exporters to export certain commodities to three or more consignees that have been preapproved as foreign distributors or users; they are considered a "special privilege," according to U.S. export regulations. Internal control mechanisms are required to assure compliance. As U.S.-China trade grows, some mechanism will be needed to permit U.S. firms to obtain a license permitting them to make repeated sales of green-zone level items to trusted Chinese consignees. Other areas for future consideration include controls on technical data exports (including training) and controls on temporary exports to trade shows.

The pending export control issues are significant ones that deserve high level attention in the United States and in COCOM. *The solutions cannot in most cases be achieved through legislation, but Congress can play an impor-*

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[60] Stephen E. Nordlinger reported that the U.S. Government had agreed to a British sale of advanced telecommunications equipment that U.S. firms had been barred from exporting on national security grounds. This sale involved fiber optics. *Baltimore Sun*, Dec. 28, 1986, p. 4A.

tant role by monitoring progress in improving the efficiency of the current sytem and in considering the commercial and national security implications of alternative future courses in U.S.-China policy.

MILITARY COOPERATION

In 1981 China was removed from the list of prohibited destinations for export of U.S. munitions list items. While more than 6 years have elapsed since that time, views differ about the appropriateness of cooperation in this area, and about how best to pursue it. Although press reports often give the impression that there is a rapidly developing military relationship between the two countries,[61] actual arms sales and military cooperation have been limited. Differences in views about arms sales to China reflect underlying concerns about whether military cooperation should be emphasized in the bilateral relationship, and how it can contribute to broader U.S. strategic goals in Asia.

It appears doubtful that U.S. sales of advanced weapons systems will increase rapidly in the near term. Differences between U.S. and Chinese perspectives on a number of issues preclude the formation of an alliance between the two countries. China's limited financial resources and its desire to obtain technology rather than import complete weapons systems also set constraints.

There are both advantages and disadvantages to the approach taken by the United States to military sales to China. Blanket restrictions on arms sales have been eliminated, and licenses to export items on the munitions list are now reviewed on a case-by-case basis. As arms sales and military cooperation proceed, however, it will be important for the United States to define more clearly those areas for military cooperation, based on evaluations of past experience. OTA also concludes that U.S. officials making decisions on dual-use exports should be more aware of the scope and nature of munitions sales.

Since 1981, U.S.-China military cooperation and U.S. arms sales to China have been expanded. However, U.S. commercial arms exports to China do not compare with those to South Korea, Indonesia, or Taiwan in dollar value, and official military cooperation has been limited. Table 21 provides a comparison of U.S. commercial arms sales to selected destinations.

Several high-level discussions have occurred, beginning with a visit to Beijing by Harold Brown, Secretary of Defense in the Carter administration. The general framework for U.S.-China military cooperation was established in a 1983 visit by Secretary of Defense Caspar Weinberger. The components are a high-level strategic dialogue between military leaders, functional military exchanges, and the identification of several military mission areas for cooperation. High-level visits continue—the most recent in May 1987 when Yang Shang Kun, Vice Chairman of the Central Military Commission, was hosted by Vice President George Bush.

During this 6-year period, four military-related sales have received public attention. Two cases involved sales of civilian technology to Chinese military end users: 24 civilian derivatives of Sikorsky Black Hawk military heli-

Table 21.—U.S. Commercial Arms Exports (thousands of dollars)

	1981	1982	1983	1984	1985	Total
China	0	1,000	984	22,732	3,151	29,516
Japan	344,862	300,000	439,238	546,874	301,647	3,014,444
Korea	28,710	25,000	123,513	122,299	36,041	615,258
Indonesia	6,673	10,000	25,083	27,197	23,088	132,570
Taiwan	66,731	75,000	124,785	133,133	100,000	838,337

NOTE: Dollar value of deliveries of munitions-controlled items purchased directly from U.S. manufacturers. Data do not include official U.S. Goverment programs such as foreign military sales. In the case of Korea, for example, such official sales were valued at $266 million in 1985.

SOURCE: Department of Defense, Security Assistance Agency, *Foreign Military Sales, Foreign Military Construction Sales and Military Assistance Facts* (as of Sept. 30, 1985).

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[61] See, for example, Edward Neilan, "Peking, U.S. Brass Getting Along Well," *Washington Times*, May 14, 1986, p. 7.

copters[62] in 1984 and 5 General Electric turbine engines to the Chinese navy in 1985.

The other two cases involve foreign military sales (FMS)—direct government-to-government transactions.[63] The most significant completed sale of an item on the U.S. munitions list was artillery shell technology. While some observers expected China to spend $500 million on artillery manufacturing equipment, the final value of the transaction was about $22 million.[64] In May 1986 U.S. approval was given for an FMS sale of 55 avionics kits ($10 million each) to modernize China's F-8 fighter. In late 1986 it was reported that the U.S. Air Force had signed a $501 million contract for the avionics upgrade and planned to issue requests for proposals for the first 50 avionics kits, to be delivered in 1991.[65]

It appears that negotiators from the United States and China have concentrated their discussions primarily on mission-specific systems used for tactical defense,[66] including antitank weaponry that China needs to defend its border against the Soviet Union. Repeated reports of discussions over TOW antiarmor missiles fall into this category. Another area is improved air defense. I-Hawk antiaircraft missiles are among the weapons that have been considered. A third area is antisubmarine warfare, where potential sales of towed-array sonars, and the Phalanx ship defense system have received some public attention.[67]

U.S. officials indicate that, for the most part, such systems would not significantly improve Chinese capabilities to launch an offensive attack and that they involve limited advanced technology transfer. Military sales to date have involved little production technology or complete weapons systems. Observers note that applications for export of military hardware or technology more than 5 years old are viewed favorably by U.S. license reviewers.[68]

All U.S. commercial arms sales are regulated by the International Traffic in Arms Regulations (ITAR), as implemented by the Office of Munitions Control in the Department of State. DoD's Munitions Directorate reviews some but not all of the munitions export applications. In recent years DoD has reviewed about one-fourth of the roughly 40,000 applications for munitions exports worldwide submitted annually.[69] DoD reviews a higher percentage of applications for export to China.[70] The cases that DoD reviews are the cutting-edge cases—those not previously licensed for a particular export market.

The review process involves the Department of States, DoD, and various military departments and agencies, with industry representatives providing information. Many of the key cases that DoD reviews require careful consideration of the interests of different military agencies involved, depending on the type of technology or equipment. DoD officials taking the lead in munitions case reviews look to International Security Affairs (DoD) for policy guidance, taking an activist approach designed to build consensus on a joint DoD position.

When sales involve major defense equipment, valued at $14 million or more, or when defense articles and services valued at $50 million are proposed, the President must notify Congress 30 days prior to transfer.[71] Congress rarely musters the votes to block arms sales proposed by the executive branch, but anticipated opposition from Members of Congress may cause administration officials to defer a sale. In the spring of 1986, Congress reviewed the proprosed F-8 avionics package, which was eventually approved.[72] U.S. arms exports to China also receive COCOM reviews.

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[62] The helicopters included military engines.

[63] Since 1984 FMS has been available for China. In addition, 4 Mark 46 antisubmarine missiles and some training have been provided through FMS.

[64] Roger W. Sullivan, "U.S. Military Sales to China," *China Business Review*, March/April 1986, p. 6.

[65] The kits include new radars, inertial navigation equipment, head-up displays, air data computers, and a new data bus. See *Aviation Week and Space Technology*, Nov. 24, 1986, p. 28.

[66] See Kerry B. Dumbaugh and Richard F. Grimmett, *U.S. Arms Sales to China* (Washington, DC: Congressional Research Service, July 8, 1985).

[67] The United States agreed in principle to discuss cooperation in modernization of the People's Liberation Army antisubmarine capabilities. See Report to Congress, fiscal year 1986, by Secretary of the Navy John F. Lehman. See ch. 7 for a discussion of issues surrounding possible transfers of antisubmarine warfare technologies.

[68] Sullivan, op. cit., p. 8.

[69] DOS unilaterally reviews the other 30,000.

[70] A reasonable estimate is that DoD reviews about 80 percent of the China munitions cases. Estimate will be verified.

[71] Sec. 36 9(b) (1) of the Arms Export Control Act.

The number of munitions export cases is small in comparison with dual-use cases. In 1985, the U.S. Goverment reviewed 11,000 applications for dual-use exports, and a total of 269 applications for munitions sales to China. As table 22 shows, the percentage of applications denied is higher and the share of those approved lower for munitions applications than for dual-use exports. Fewer than 1 percent of the dual-use applications were denied and more than 70 percent approved in 1985. In the same year, 60 percent of the munitions cases were approved (20 percent approved with provisos), and 11.5 percent denied.

Out of the total 860 munitions applications reviewed over the course of the past 6 years, about 150 involve equipment exports reviewed by COCOM. In the past year, the number of applications has increased (as shown in table 17). During the first 5 years of the 1981-86 period, 80 cases were sent to COCOM. During the period August 1985 through July 1986, another 70 cases were submitted to COCOM, indicating growth in munitions applications for China. Since 1982, U.S. cases have made up 60 percent of all COCOM munitions cases for China.[73] Other countries such as Italy are also providing China with military technology subject to COCOM review.[74]

Table 22.—Munitions Licensing for China, 1981-86

	Numbers of cases						
	1981	1982	1983	1984	1985	1986	TOTAL
Approved	5	28	60	83	109	50	335
Denied	—	12	15	31	31	23	82
Returned without action	4	17	40	57	69	40	227
Proviso	3	17	25	34	55	29	163
Total	12	44	140	197	269	198	860

NOTE: Data for 1986 through Sept. 9. Totals may not add up because a few cases have been canceled or lost. Cases do not include temporary exports.

SOURCE: U.S. Department of State, Office of Munitions Control, data provided to the Office of Technology Assessment, September 1986.

In some cases, reviews of munitions cases are completed within a month of receipt of application, although cases sent to COCOM often take much longer. The task of licensing munitions exports may be more manageable than that of dual-use exports because there are fewer applications to review. While there have been few trade missions to China by U.S. industry officials involved in arms sales, this situation may change in the years ahead.

Issue: Is There a Discrepancy Between Dual-Use and Military Exports?

Some observers have charged that there is a disjunction between U.S. dual-use and military exports to China. To cite one example, some argue that there is a discrepancy between U.S. reluctance to provide bulk licenses for microcomputers and the fact that discussions are under way about assisting China in improving its surface-to-air missile systems. The promptness of decision making and the attention given to any reports of talks concerning arms sales to China leave some observers with the impression that it is easier to get an approval for military exports than it is to get approval for dual-use exports.[75]

Arms exports and dual-use exports are covered by different sets of regulations, and licensing is handled by different government agencies. There is no simple basis for comparing the levels of technology in arms sales and dual-use sales. The former have specific military applications, whereas the latter (as discussed in ch. 7) may be used more generally by the military and require modification. OTA has not conducted a systematic analysis of the relationship between dual-use and military exports to China. *However, the available data do not suggest that military exports to China to date have outpaced dual-use exports in technology level. Moreover, the volume and dollar value have been much lower.*

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[72] For a summary of the arguments against the sale, see Martin L. Lasater, *Arming the Dragon: How Much U.S. Military Aid to China?* (Washington, DC: Heritage Foundation, Lecture No. 53, April 1986).

[73] Data provided to OTA by the Office of Munitions Control, September 1986.

[74] An official from China National Aero-Technology Import and Export Corporation stated that Aeritalia was assisting China in developing the A5-M, a supersonic, twin-jet attack aircraft to be used by China and exported. See FBIS, *Daily Report, China*, Nov. 6, 1986, p. A4.

[75] See comment by Madelyn C. Ross, "China and the United States Export Controls System," *The Columbia Journal of World Business*, spring 1986, p. 31. In order to analyze this question, it would be useful to compare the technology involved in *actual* exports of dual-use and munitions items.

There is a separate but related question about the resources devoted to reviews. Reviews of applications to export lower-level, dual-use equipment can be quite lengthy, leaving many participants to conclude that U.S. agencies waste time focusing on such cases while munitions cases are handled more expeditiously. *However, the comparatively higher percentage of denials for munitions applications suggests that reviewers are no more willing than their counterparts reviewing dual-use exports to approve exports.*

No systematic comparison is made between dual-use and munitions export. *In the future, as military exports increase, comparisons of dual-use and military exports may be needed to ensure consistent policy implementation.* Information about recent military sales of certain types could, for example, be useful to those reviewing policies of related dual-use technologies. It will also be important to develop clearer guidelines about the types of military technologies and equipment permissible for export and those that, for reasons of national security, cannot be exported.

Issue: How Far Should the United States Go in Military Cooperation?

U.S. policy is based on the belief that military cooperation is a natural part of an evolving bilateral Sino-American relationship that is nevertheless unlikely to become an alliance. Seen from this perspective, gradual steps toward expanded military cooperation will not create Chinese "dependence" on U.S. technology, but rather build shared experience in a few key areas.

The future of U.S.-China military cooperation, however, remains uncertain. This is partly because experience is limited and comparatively new, and more importantly because U.S. policies have not clearly defined thresholds for U.S. sales and assistance. General statements about "mission areas" come the closest to identifying types of exports that are unlikely to grow rapidly.

It may be useful to consider the range of alternatives available in the realm of military cooperation. Through high-level consultations and dialogue, Chinese and American officials share their perceptions of important strategic issues. Exchanges of military personnel are another mode for military cooperation. If exchanges can be developed in a truly reciprocal manner, they provide military officers with new experience and understanding of the roles played by their counterparts.[76] Military cooperation could also include intelligence sharing, port calls, and joint exercises.

Sales of equipment and technology, including training and maintenance, are perhaps the most publicized dimension of the evolving relationship in the military realm. One issue is the extent to which such sales will be conducted on a government-to-government basis. Some observers believe that the Chinese would prefer not to use FMS because this involves relying on DoD to act as a middleman between the Chinese buyer and the U.S. producer.[77] Another issue is whether or not U.S. sales will be directed toward improving China's own military forces or toward providing China with equipment and technology needed to expand its own arms exports.

It is well to remember that an array of factors will probably limit U.S.-China military cooperation, despite the gains that might be achieved in increased mutual understanding, intelligence sharing, and in strengthening China's ability to defend itself against Soviet aggression. On the Chinese side, these constraints stem directly from a desire to avoid dependence on any outsiders and a determination to pursue an independent foreign policy. On the U.S. side, uncertainty about China's future policies and effects on other Asian countries remain important constraints.

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[76] Some observers conclude that U.S.-China military exchanges to date have not been reciprocal—that the United States has given much more than it has received.

[77] Sullivan, op. cit., p. 9. An Atlantic Council report favored use of FMS sales on the grounds that they "permit the U.S. to be responsive yet retain sufficient controls over what China can buy . . ." See *China Policy for the Next Decade*, Atlantic Council, 1983, p. 39.

Taiwan is a case in point. Since the early 1980s, when the United States decided to permit arms sales to China, the Chinese Government has objected to continued U.S. arms sales to Taiwan. The Taiwan Relations Act of 1979 provided for continuing U.S. support of Taiwan's defense requirements, while the Shanghai communique of 1982 states that the United States "does not seek to carry out a long-term policy of arms sale to Taiwan, that its arms sales to Taiwan will not exceed, either in qualitative or quantitative terms, the level of those supplied in recent years since the establishment of diplomatic relations between the United States and China . . ."[78] Built into U.S. arms sales policy is thus a delicate balance of U.S. interests vis-à-vis China and Taiwan.

Each major arms sale to either party raises opposition and concern in some quarters. The United States continues to sell Taiwan more than $600 million in arms annually. China objects to these sales. It was reported, for example, that Beijing recently questioned U.S. transfers of technology Taiwan needs to develop it own fighter aircraft as contrary to the terms of the Shanghai communique.[79] In the past, the United States refrained from selling Taiwan certain kinds of military equipment (such as the F-20). The U.S. Government has pursued sales such as the recent F-8 avionics package for China despite criticism from Taiwan and its supporters. Continuing differences in perspectives over Taiwan will, however, limit U.S. military cooperation with China because interested parties will carefully scrutinize proposed new arms sales to China in this context.

Some may wish to avoid all transfers of military equipment and technologies on the grounds that these are not the kinds of transfers that China most needs, or that building China's military could threaten neighboring Asian nations even if there is no significant threat posed directly to the United States. Others see military cooperation as essential to an evolving U.S.-China relationship. The United States can benefit from certain types of cooperation with China that expand knowledge of Soviet activities and deepen understanding of China's military and the role that it plays in Chinese modernization.

The shape and nature of U.S.-China military cooperation must be further defined and based on growing experience that permits policy makers to evaluate risks and benefits to the United States. It will be important to review the record periodically and update U.S. export guidelines in light of changes in technology and (most importantly) political relations. As discussed in chapter 7, case-by-case decisions on munitions applications must reflect a broader strategy designed to promote U.S. interests.

While military cooperation has been limited and will likely remain so in the near term, it is important to recognize that it carries symbolic importance. Discussions between Chinese and U.S. military officials send important signals to the Chinese and to other countries in Asia. U.S. policy makers may wish to keep this broader context in mind as they define the scope, nature, and future of U.S. military cooperation with China.

SCHOLARLY AND TECHNICAL EXCHANGES

A wide range of activities between the United States and China are referred to as science and technology (S&T) exchanges. These include exchanges of students and scholars, which have brought some 17,000 Chinese to U.S. institutions of higher education, and the varied exchange and cooperative activities under the 29 protocols signed by the technical

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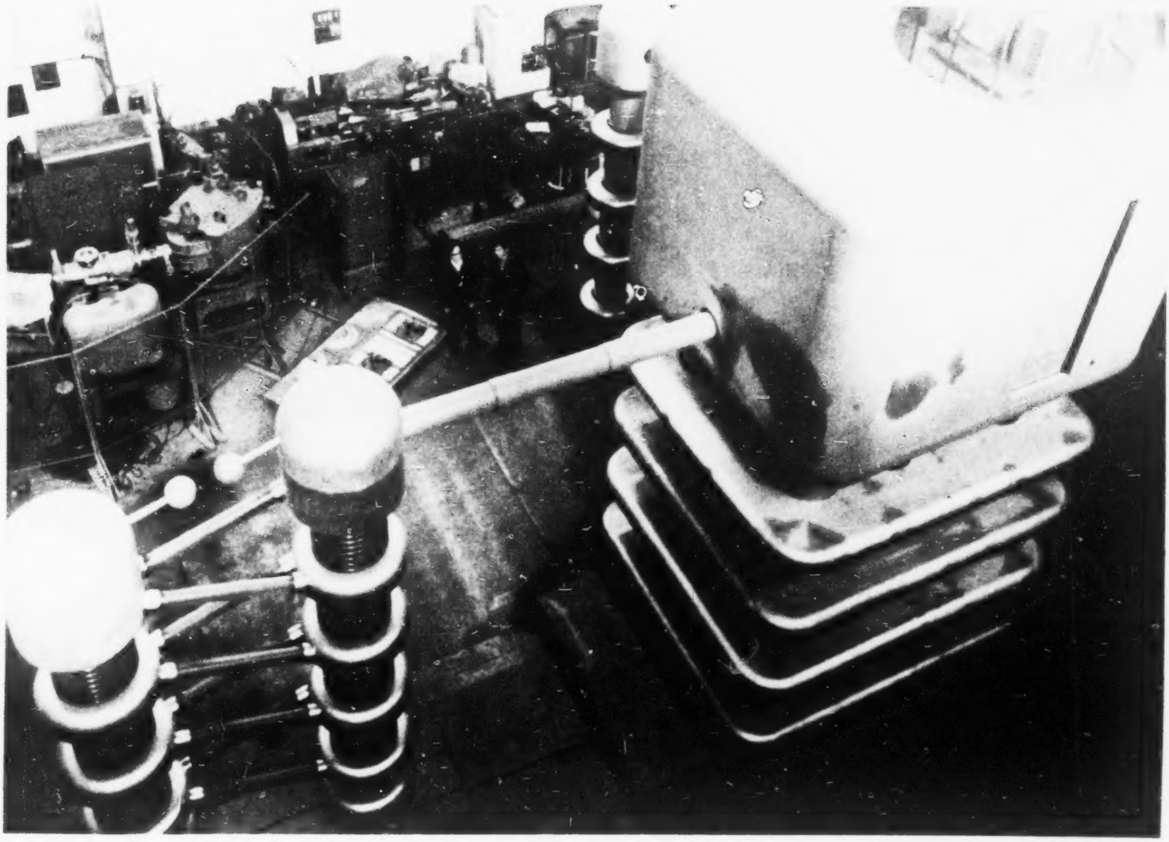
[78] Joint Communique of Aug. 17, 1982.

[79] Nayan Chanda, "A Technical Point: U.S. Rejects China's Stance on Technology Transfers to Taiwan," *Far Eastern Economic Review*, Aug. 26, 1986, p. 26.



Xinhua News Agency

A 600,000 volt heavy-iron injector manufactured in Shanghai. It is used in the semiconductor industry and in materials research.

agencies of the U.S. Government and its Chinese counterparts.

The diplomatic foundation for Sino-American S&T exchanges is the U.S.-China Agreement on Cooperation in Science and Technology of 1979. Under this umbrella agreement are the Agreement on Cooperation in Educational Exchanges and 28 other agency-to-agency agreements. Activities under the umbrella agreement are overseen by the U.S.-People's Republic of China (PRC) Joint Commission on Science and Technology, which meets biennially. Since the agreement was signed, there has also been a proliferation of nongovernmental exchange and cooperative activities involving universities, professional associations, and industry—including some that have explicit technology transfer dimensions, such as the agreement between Georgia Tech and the Chinese Association for Science and Technology.

Although there have been some problems for the United States in the areas of reciprocity and access to Chinese research sites and materials, the exchange programs have been successful in achieving most of their initial main objectives. These objectives—in addition to the manifest objectives of S&T cooperation and assisting China in its modernization—included the improvement of political relations, the establishment of knowledgeable relations between the technical communities of the two countries, and the cultivation of informed understanding, if not sympathy, toward the

United States among a new generation of Chinese elites. Less clear is the contribution of the exchanges to the promotion of U.S. commercial interests in China.

This section outlines the scope of the exchanges, including both student and scholarly exchanges and activities under the sponsorship of the bilateral agreements, and considers options for strengthening the exchanges.

Student and Scholarly Exchanges

The direct Federal Government role in supporting the education of Chinese scientists and engineers, while crucial at the inception of the program, is now relatively small in comparison with activities conducted in the private sector and through universities.[80] Indirectly, however, the Federal Government is involved through the research support it provides to universities, some of which supports Chinese graduate students and visiting scholars. The monetary value of this support is difficult to determine.

The education in science and engineering provided to Chinese students in U.S. (and other foreign) universities is arguably the most important contribution to the development of Chinese technical capabilities now being made, whether it is called technology transfer or not. It is fair to say that the Chinese see it this way as well, and having access to our universities is a powerful inducement to the Chinese. From the U.S. point of view, there is clearly the hope that China's future scientists and engineers will leave the United States with favorable images not only of U.S. society generally, but also of U.S. technology.

Although the student and scholar exchange program gives the United States a powerful policy tool, it does not lend itself to fine-tuned policy intervention, either for promoting technology transfer or for controlling it. If Congress wishes to encourage more exchanges, it could increase the budgets of those agencies that have a role in supporting them, such as the National Science Foundation and the U.S. Information Agency. However, if it wishes to do less, the reduction of China-related activities in those agencies would affect only a very small portion of the total exchange activity. To make more of an impact in reducing exchange activities, the United States would have to use other means, which would represent major changes in China policy and would affect other non-China-related values. Thus, limiting the issuance of visas or attempting to limit Federal funds used to support Chinese graduate students would signal a change in U.S. friendly intentions toward China, and would also compromise academic values and principles supporting the free movement of people. Efforts to limit the access of Chinese to sensitive research must be seen in the context of the larger controversies over the limitation of foreign nationals on national security grounds to sensitive U.S. research, controversies that must be approached with care since they involve clashes of very basic U.S. values.

The large numbers of Chinese students and scholars coming to the United States indicates that the U.S. university system is a magnet to students from around the world. The growth of the foreign student population raises many important issues about the U.S. role in sustaining international science, the costs and benefits to the United States of playing this role, and the implications for U.S. technological competitiveness with regard to trade and national security.[81]

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[80] This is not to say that the Government is not involved in exchanges. The U.S. Information Agency (USIA), National Science Foundation (NSF), and National Endowment for the Humanities (NEH), for instance, all support exchange activity. USIA and NEH support, however, goes mainly to support Americans studying in China, while NSF supports collaborative research and exchange activities in the sciences, administered by the Committee on Scholarly Communications with the People's Republic of China. When compared with the extensive educational exchanges conducted independently of the Federal Government, however, these federally supported programs are not large. For an account of the distribution of effort in sponsoring exchanges, see U.S. National Academy of Sciences, *A Relationship Restored: Trends in U.S.-China Educational Exchanges, 1978-1984* (Washington, DC: National Academy Press, 1986), ch. 4.

[81] Dorothy S. Zinberg, "Sending Ideas Abroad: The Education of Foreign Scientists and Engineers," unpublished paper, Center for Science and International Affairs, Kennedy School

The Bilateral Agreements

Although the amount of government-to-government S&T activity varies from protocol to protocol, the government-to-government bilateral agreements have also been, on balance, quite successful. Activities under the protocols have also done much to bring the technical communities of the two countries together, to improve political relations, and to offer mutual scientific benefits. In terms of the number of protocols, the U.S.-China S&T program is the largest bilateral program maintained by either country.

When the government-to-government programs were begun, they received high level attention from the President's Science Advisor, the Office of Science and Technology Policy (OSTP), and the NSC, and active interagency coordination from the Department of State. As the programs began to succeed, their administration became more routine, and high-level attention decreased (even though interest at OSTP and in some offices at the State Department has remained high).[82] In recent years, partly due to the decentralizing reforms in Chinese S&T, there has been a proliferation of new activities involving units of the two governments outside the framework of the protocols. These developments have led some observers to ask whether the time may not be right for a reexamination of the programs.

U.S. participation has been funded out of the regular domestic budgets of the technical agencies on the basis of the value of participation for the agency involved. While this approach has a number of virtues, it means that there may be areas where the domestic agency has no interest in programs with the Chinese even though there may be foreign policy or commercial benefits for the United States and a high degree of Chinese interest.

In recent years, the growth of activities and the relative success of the programs have led to an increase in the managerial requirements for the entire program of bilateral exchanges. The science office in the U.S. Embassy in Beijing now includes four positions and is one of the largest in the world. The program as it now stands, strains the managerial capabilities of the Government; yet, at the same time, more could be done by way of interagency coordination and liaison with the private sector to obtain more benefits from the program for the United States.

The U.S.-PRC Joint Commission on Science and Technology in recent years has tended to focus mainly on the activities under the agreement and less on the broader range of S&T issues facing the two countries (as it did in its early years). Since the activities under the agreement have become more routinized, and in general are going smoothly, the activities of the joint commisssion have become more symbolic, and the time and money spent for its meetings have been questioned.

Other questions about the programs pertain to whether the United States can capture more commercial benefits from the programs and whether it would be a good idea to establish a formal aid program for China.

Issue: What Could Be Done To Expand Technology Transfer Under the Bilateral Agreements?

The U.S.-China program presents opportunities for promoting technology transfer if the United States wishes to pursue a more active strategy.

One possibility would be to provide supplemental funding for the programs under the protocols so that agencies now facing financial constraints could become more active. A suggested approach would be the creation of a modest budgetary allocation for activities that would advance foreign policy and/or commercial interests but that cannot be justified out of current agency budgets in terms of domestic mission requirements.

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of Government, Harvard University, September 1985; National Science Board, *Science Indicators: The 1985 Report* (Washington, DC: U.S. Government Printing Office, 1985), pp. 18-20.

[82] It is perhaps telling that there is only one person at the OSTP level with responsibility for international cooperation, with China being but one country among many falling within the area of responsibility of this position.

In the course of examining technology transfer in the surface transport area, for instance, OTA consulted with the Department of Transportation (DOT). Although DOT negotiated an agreement with Chinese counterparts, there has been little activity, partly because DOT does not see the justification for spending resources on programs that will not advance the Department's mission.

Yet, in light of China's pressing needs in the transport sector and the considerable expertise residing in DOT, there would appear to be benefits for both countries if a program of cooperation were begun. The potential benefits to the United States would be even greater if such a program of cooperation involved the private sector, and if U.S. participation were designed so that the Chinese could be exposed to the transport technology available from U.S. industry. Inasmuch as DOT does not see a departmental interest that would justify spending on such a program from its domestic budget, a new approach to funding would be necessary.

Another possibility would be to expand private-sector representation on the U.S. side of the Joint Commission, to broaden the perspective of the Commission and to identify better the commercial prospects associated with programs. The U.S. private sector has suggested commercial representation in the cooperative programs with Japan and Korea, countries where technology-based competitive commercial pressures are greater than they currently are with China. Expanding private-sector representation on the U.S.-China Joint Commission could help insure an informed industrial perspective on the bilateral agreements, and on China's development of technological capabilities. Planning for the meetings should afford the United States an opportunity to take stock of its entire S&T relationship with China. Participating in the meetings would permit better representation of U.S. commercial interests. This would entail, however, changes in staffing and management in the Department of State and the OSTP, more high-level attention to the importance of S&T in the Department of State, and more active and enlightened interagency coordination.

While there is some evidence that activities in the bilateral programs have led to some equipment sales, there has been no systematic effort to assess the value of the programs for U.S. exports. This also appears to be the case for the Dalian management training program, run by the DOC. *The State Department and the OSTP could assess the commercial impacts of the programs and make a stronger effort to inform businessmen and trade promotion officials in the Foreign Commercial Service (FCS) about opportunities.* Closer coordination between the S&T office in the U.S. Embassy in Beijing and the representatives of the FCS there would be one mechanism.

PROMOTIONAL POLICIES

Since the normalization of relations between the United States and China in 1979, trade has been viewed as an area of "great promise."[83] But in 1986, U.S. exports to China were lower in dollar value than the 1980 level, although the composition of those exports has shifted away from foodstuffs and materials and toward machinery and equipment.[84] U.S. market share in China has actually declined over the past few years.

There are a variety of explanations for these trends, including the possibility that Japanese firms may be better positioned to compete for certain segments of the China market than U.S. firms are. U.S. business may, at any rate, have learned important lessons in trading with

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[83] See, for example, White House Press release, Apr. 27, 1984.

[84] Current U.S. dollars: in 1980 U.S. exports were valued at $3.7 billion; in 1986 exports were valued at $3.1 billion. These are official U.S. trade data. According to U.S. trade data, the U.S. ran a trade deficit with China of more than $2.1 billion in 1986. Chinese statistics show that China imported more from the United States than it exported.

China over the past 7 years. Now there is a general recognition that China wants U.S. technology and investment, as much if not more than it wants U.S. imports of finished products.

Many U.S. exporters and some Government officials believe that the U.S. should be able to do better in exporting to China. The purpose of this section is to examine the U.S. policies and programs that, broadly defined, support expanded trade and technology transfer. In contrast to Japan, the United States has not developed a systematic effort to promote exports to China. On the other hand, small programs like TDP have been well received. *The U.S. Government could do more to support U.S. exporters, through focused programs like TDP that permit U.S. firms to help shape development projects at an early stage, by stronger leadership in actively seeking opportunities for U.S. business, and in coordinating efforts.* Such an approach might include selected use of financing support, but more important would be a national-level commitment to expand U.S. exports in particular sectors such as telecommunications, where technology transfer as well as exports of equipment and services are essential for meeting China's modernization goals.

But as important as China is, U.S.-China trade should not be viewed in isolation from larger policy issues. Whether and how the United States chooses to formulate a more coherent approach to promoting U.S. competitiveness and global trade is the key issue on the broader international economic policy agenda. China is arguably a good test case in the sense that prospects for expanded trade are greater here than with many developing countries that suffer from high debt and sluggish growth. But U.S. Government policies, however promotional, are only one element. The future shape of U.S.-China trade will be more directly affected by decisions taken by U.S. firms themselves and by the Chinese Government, particularly with regard to regulation of foreign business. Important too will be the approaches taken by Governments in other countries such as Japan, where expanding imports from China and other developing countries could relieve pressure on U.S. markets and send a strong signal of support for an open Asian market.

The United States and China have several bilateral agreements that provide a basis for trade and technology transfer. Under the bilateral trade agreement that became effective in 1980, the two countries provide most favored nation (MFN) treatment for imports,[85] arrangements for business representation, and settlement of trade disputes. China also agreed to provide patent, trademark, and copyright protection equivalent to that of the United States.[86] In contrast to the trade agreements between Japan and China, where the two countries set specific goals for imports and exports of certain types, the U.S.-China agreement contains no numbers or specific sector targets.[87]

The U.S.-China grain agreement, which included annual targets for Chinese purchases of 6-8 million metric tons of U.S. wheat and corn during the 1981-84 period, has now expired. China did not meet the targets during the final two years, in part to show resistance to U.S. restrictions on Chinese textile imports into the United States. As China became the largest exporter of textile and apparel goods to the United States in 1987, pressure grew within Congress to restrict imports from China and other countries.[88] A major change in policy was the recent announcment that the Zhenjiang provincial Government would begin pur-

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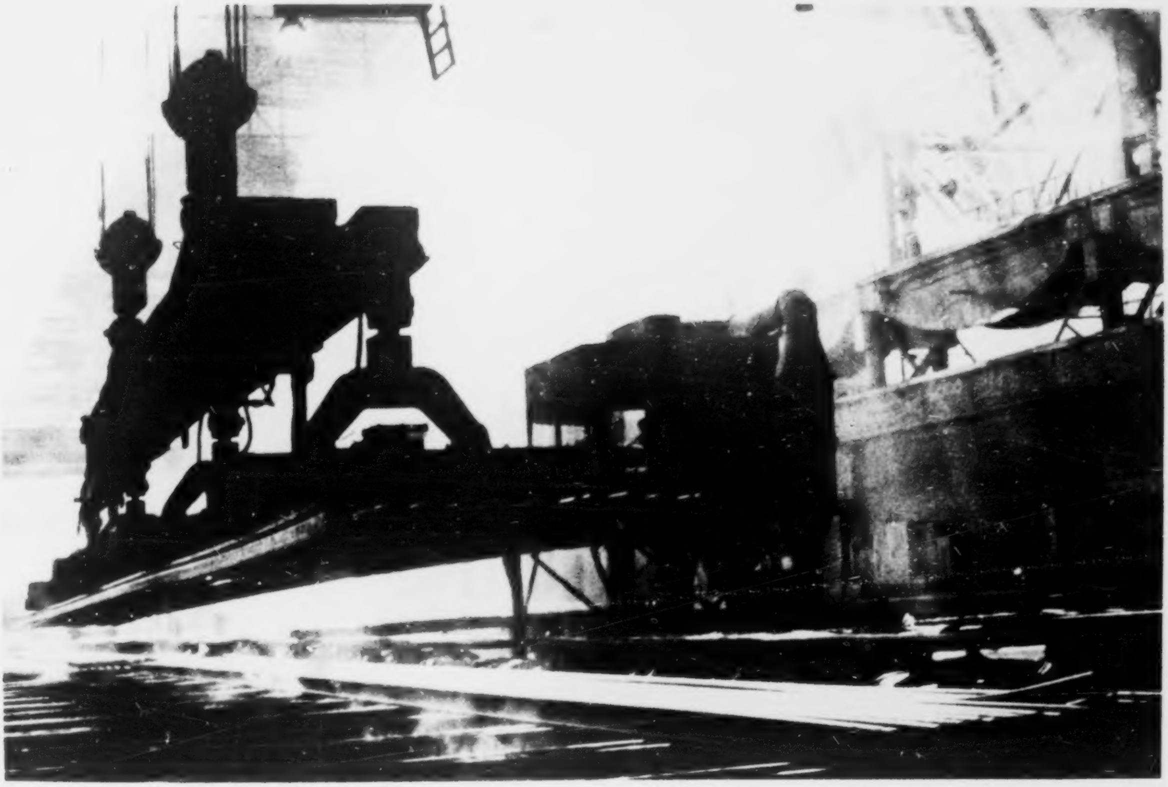
[85] The United States has decided to continue MFN status for China by using general waiver authority under the Jackson-Vanik amendment (of the 1974 Trade Act). A decision was taken in June of 1986 in the form of a presidential message to Congress, and elaborated upon in State Department testimony before the House Ways and Means Committee.

[86] Agreement on Trade Relations Between the United States of America and the People's Republic of China, 1979.

[87] The Japan-China agreement, for example, set targets for Chinese exports of crude oil and coal to Japan. The targets have not been met in many cases. The Japanese oil industry, for example, was unenthusiastic about importing waxy Chinese crude oil. See ch. 5 on supplier country policies for a more detailed discussion.

[88] This legislation, known as the Jenkins bill, did not become law in the summer of 1986 but was introduced in early 1987. The current textile agreement with China is effective through the end of 1987. It places quotas on 67 categories of Chinese textile and apparel exports. The United States has the right under the treaty to negotiate quotas when imports disrupt the U.S. market.



Xinhua News Agency

Steel rails ready for shipment at the Panzhihua Iron and Steel Co. China's steel production is rising, and technology transfer has been an important factor.

chasing U.S. grain and might buy as much as 50 million tons of corn over the next 5 years.[89]

Textiles remain the primary irritant in U.S.-China trade. The current bilateral textile agreement with China places import quotas on a large number of items and permits the United States to negotiate further quotas when imports disrupt the domestic market.[90] At least 20 categories of textile and apparel goods were under unilateral embargo by the U.S. in the spring of 1987 because they were found to have injured U.S. textile producers. China depends on exports of textiles and apparel for a quarter of its export earnings.[91] Exports to the United States climbed to more than $760 million in the first half of 1986, about a quarter of total exports to the United States in dollar value. As Chinese textile exports continue to expand, some within Congress continue to call for the protection of U.S. industry and U.S. administration officials warned that rapid growth in imports would not be permitted. The bilateral textile agreement with China expires in December 1987.

Other detailed U.S.-China agreements include nuclear cooperation, industrial and technological cooperation, and taxation.[92] The United States and China are still negotiating an investment treaty, however. Critical differences remain over issues such as dispute settlement and compensation for expropriation. While the absence of a bilateral investment treaty with China may not put U.S. firms at a disadvantage vis-à-vis the Japanese, for example, some believe that it is one element in a climate of uncertainty that limits U.S. business investment.[93]

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[89] China has itself exported a record 6 million tons of corn during the 1985-86 market year, but the southern provinces have difficulty obtaining grain needed for livestock, meat, and shrimp production, some of which is destined for export.

[90] Quotas cover 75 percent of U.S.-China textile trade. See Jerome Turtola, "Textile Trade Tensions," *China Business Review*, September-October 1986, p. 27.

[91] Export earnings for 1985 were $4.36 billion.

A number of U.S. programs support technology transfers to China, although that is not the primary goal in most cases. Among these are agreements for S&T cooperation in specific areas such as telecommunications.[94] (Policy issues concerning these agreements are discussed more fully in the previous section). Under the industrial and technological cooperation accord, a number of sector-specific trade missions and seminars have been sponsored.[95]

The United States and China have also institutionalized bilateral consultations on issues relevant to technology transfer. The Joint Commission on Commerce and Trade (JCCT) discusses trade and commercial issues at its meetings. It is staffed mostly by DOC, which is also responsible for the industrial technology cooperation projects mentioned above. The Treasury Department is the lead U.S. agency on the Joint Economic Commission, which deals with macroeconomic issues, including investment.

FCS staff of DOC assist U.S. businessmen in doing business in China and in organizing the missions associated with the work programs under the industrial cooperation agreement that put U.S. business in touch with Chinese buyers.[96] FCS personnel stationed in China perform an important liaison function between potential Chinese buyers and U.S. sellers of equipment and technology. There are now 11 professional FCS staff in China.[97]

The Dalian Management Center, a joint U.S.-Chinese effort, is another mechanism for transferring U.S. management skills to China. The center's more than 1600 graduates include many who now hold high positions in Government and industry in China. The lead agency on the U.S. side is the DOC. In the case of the Dalian program, short-term as well as long-term prospects are uncertain because of funding problems. Many other supplier countries fully fund multimillion dollar management training centers under the auspices of their aid programs, but the U.S. program has been jointly funded by the two countries. The Chinese apparently favor continuation of a government-to-government program, with a larger share of funding from the U.S. Government.

The Export-Import Bank of the United States has, over the years, offered a variety of financial services, including loan guarantees and direct loans to both U.S. exporters and foreign buyers. Between 1979 and the fall of 1986, the ExIm Bank had issued only three direct loans for China exports.[98] The total value of these loans was $120 million.

Table 23 provides an overview of ExIm programs affecting China trade. Major projects under consideration include power stations,

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[92] Ratification of the tax treaty signed in 1984 was blocked by Senator Jesse Helms until June 1986, when the Senate Foreign Relations Committee approved a special protocol negotiated by Treasury Secretary James Baker. The protocol bars resident firms from third countries from benefitting from the treaty, thus eliminating opposition that had been raised on the grounds that it would permit "treaty shopping." U.S. officials indicated that the treaty would significantly reduce the taxes paid by U.S. firms to the Chinese Government and that high-technology firms in particular would benefit.

[93] The United Kingdom and West Germany have signed bilateral investment treaties (BITs) with China; Japan has not.

[94] The protocol is the latest negotiated since the 1978 umbrella agreement for S&T cooperation. Disagreements concerning fiber optics delayed the signing of the telecommunications protocol in May 1986. The telecommunications protocol is a general framework rather than a detailed outline of working programs. See OTA, *Energy Technology Transfer to China*, 1985, for a discussion of energy-related agreements.

[95] "Work programs" have been developed in electronics/telecommunications, metallurgy, aerospace, industrial renovation, and machine building.

[96] In 1983 the FCS had three positions in China.

[97] There is an additional slot that is vacant. Communication with FSC in Washington, DC, December 1986.

[98] The House and Senate agreed to authorize subsidies to cover a $1.8 billion 1987 direct loan program. The conference committees also established a $300 million Tied Aid Credit Fund to counter mixed credits used by other major suppliers. The "I-Match" program proposed by the administration was retained, but significant conditions put on its use. The program permits the ExIm Bank to solicit lenders for loans to foreign purchasers and make up the difference between domestic and foreign interest rates. The ExIm Bank requested $100 million for the tied aid fund in its Fiscal Year 1988 budget proposal.

Table 23.—Export-Import Bank Programs for China, Inclusive 1979-86 (in U.S. million dollars)

Date	Amount or authorization	Buyer	Supplier	Products
Direct loans:				
9/81	28.6	China Machine	Various	Manufacturing equipment
9/81	28.4	China Machine	Combustion Eng.	Boiler and air preheat manufacturing
5/86	87.2	Huaneng International Power Development Corp.	General Electric	Coalfired power plant
Small Business Credit Program:				
1/85	4.25	Guangdong Power Dev. Co.	Bechtel	Transmission, project management
1/86	8.5	PRC	Various	Grain storage tanks
Working Capital Loan Guarantee Program				
5/83	3.0	China Native Produce	Xylo	Logs
9/83	0.683	China Packing Corp.	Tools and Machinery	Can manufacturing
3/84	1.5	China Machine ExImport	Delta Brands	Aluminum tension-leveling line
1/85	0.181	Jiangsu Import Corp.	Various	Export capital goods
2/85	0.195	Heilongjiang International	Various goods	Export capital
3/85	0.180	Shanghai Instruments ExImport	Comtec Economation	Quartz crystal resonator manufacturing
4/85	0.207	China North Industries Corp.	Various	Machine tools Computer software
4/85	0.274	China North Industries Corp.	Various	Tube pipe manufacturing equipment and technology
6/85	1.8	China Electrical ExImport	Various	production equipment

NOTE: ExIm also provided short-term insurance policies covering contracts worth about $17 million in contracts.

SOURCE: Export-Import Bank, data provided to the Office of Technology Assessment in August 1986.

transport, and telecommunications. According to ExIm officials, many of the projects supported by the bank involve significant technology transfer. The Combustion Engineering project, for example, included transfer of production know-how for boiler manufacturing.

Trade finance can be a critical element for influencing the ability of a U.S. firm to win a contract. To cite one example, a consortium led by G.E. recently won a contract to provide equipment for coal-fired power stations to the Huaneng International Power Corporation. The G.E. contract, reportedly worth $588 million, involved official export credits (see table 23) and a significant countertrade element.[99]

Since large capital-intensive projects in developing countries often depend on the support of foreign lending and guaranteeing institutions, ExIm financing can be critical. When official financing is available for a project, a U.S. bidder may be better able to pursue negotiations for projects. Once an initial contract has been won with official export financing, the prospects for followup participation in equipment and component supply normally expand. In the case of U.S. ExIm financing, 100 percent of the long-term financing provided by the ExIm Bank goes to U.S. firms, thus increasing U.S. exports.[100] The bank can provide support for projects involving service exports, technical training, and technology transfer.[101]

Views differ about the adequacy of U.S. official financing. The U.S. Government has taken the general position that the private sector should be primarily responsible for trade finance. In contrast to other supplier countries, where the provision of export credits is based on the principle that all projects that meet certain substantive criteria should be supported, the United States has turned in a period of budgetary constraint to a philosophy of supporting only those projects that demonstrate extraordinary need—for example, those that involve a competing foreign bidder assisted by government-sponsored export credit. In recent years China has preferred to use more concessional

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[99] See *International Trade Reporter*, June 4, 1986. G.E. reportedly agreed to sell Chinese goods in conjunction with the contract. See also *Financial Times* (London, Feb. 27, 1986), p. 7.

[100] U.S. firms have participated in energy development projects in China supported by the Japanese ExIm Bank.

[101] In recent years, the bank has supported projects involving licensing agreements where significant equipment exports were involved.

Table 24.—OPIC Insured Investments in China (in U.S. million dollars)

Investor	Project	Insured investment
AMC	Manufacturing 4-wheel drive vehicles	14.4
American President Lines	Containerized shipping	0.874
AMF	Manufacturing electrical relays	1.0
AMF	Manufacturing inflated balls	0.855
Caterpillar Far East	Spare parts for machines	2.0
Combustion Eng.	Produce ceramic fiber	0.378
Continental Enterprise	Feedmill, poultry hatcheries	0.900
CW Communications	Publish computer newsletter	0.110
Dresser Industries	Conductor wireline services	4.9
E.R. Squibb	Manufacturing pharmaceuticals	0.900
Essex Group	Modernize cable plant	4.1
Foxboro Co.	Manufacturing industrial process control instruments	4.4
General Foods	Manufacturing dextrin and starches	1.4
Gillette Co.	Manufacturing razors, blades	1.2
Internatl Bechtel	Establish engineering consulting firm	1.3
International Nabisco Brands	Manufacturing biscuits and crackers	4.0
Kowin Development	Establish and operate hotel	9.0
Otis Elevator	Manufacturing elevators, escalators	1.3
Pennzoil	Oil and gas exploration	100.
Smithkline Beckman	Manufacturing pharmaceuticals	3.9
Solid State Science	Manufacturing semicondutors	0.438[a]
System and Applied Science	Earth satellite station	0.425[a]
Texaco	Oil and gas exploration	50.
General Foods	Manufacturing beverages	0.873
Smithkline Beckman	Manufacturing pharmaceuticals	0.270
Total		$209.4

[a] Contractors' letter of credit insurance.

SOURCE: OPIC, August 1986, data supplied to the Office of Technology Assessment.

aid-type financing that is available from other supplier countries at lower interest rates. Some believe that the United States should offer more official financing, perhaps in the form of mixed credits. This issue is discussed below.

At any rate, prospects for use of ExIm credits may have improved as U.S. interest rates declined in 1986.[102] In October 1986, ExIm Bank Chairman John Bohn stated that the bank was considering loans for projects in China totaling just under $1 billion.[103]

OPIC also provides financial services for U.S. firms. In contrast to ExIm programs, OPIC's goal is to support direct investments in developing countries through loan guarantee and insurance programs. By August 1986 OPIC had insured 20 U.S. investors (covering investments valued at $209 million) against political risk in China. Table 24 provides a list of those investments.

OPIC has issued only one loan for a project in China, to help finance the design and building of a satellite earth station. Up until January 1986, OPIC was able to fund feasibility studies, but this program has been ended because of budgetary constraints. OPIC supports visits to exchange information about investment opportunities. Examples include sponsorship of a trip in 1984 by U.S. corporate executives and a grant to the National Council for U.S.-China Trade to help assist the Chinese in identifying and facilitating U.S. investment opportunities in China.

But U.S. investment in China remains limited, certainly below Chinese expectations. As mentioned earlier, the United States and China have been unable to reach agreement on an investment treaty, despite prolonged negotiations since 1983. While some question whether a bilateral investment treaty would make much difference, the absence of an agreement is taken by others as an indication that the groundwork has not yet been established for secure investments.

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[102] See U.S. Export-Import Bank, *Report to the U.S. Congress on Export Credit Competition and The Export-Import Bank of the U.S.*, September 1985, pp. 3-5.

[103] "Bohn Says PRC Eximbank Loans Could Total $1 Billion, Hits Unfair Use of Mixed Credits," *International Trade Reporter*, Nov. 5, 1986, p. 1330.

TDP is one of the more successful U.S. promotional programs. Established in 1980, TDP's dual mission is to assist developing countries and to support U.S. business in competing for markets in technology, equipment, and services. TDP is run by the Agency for International Development, but it is quite different from a traditional aid program. TDP accomplishes its dual missions with a modest budget of $20 million annually, which it uses to provide financial support for project planning services, especially feasibility studies. China-related programs today constitute the largest part of TDP, making up 30 percent of TDP's worldwide program, or about $4.3 million committed in fiscal year 1986.

TDP, which interacts directly with the Chinese Ministry of Foreign Economic Relations and Trade (MOFERT),[104] has been well received in China. It's approach is to support key project planning activities that often lead to exports many times the value of the original feasiblity studies.[105] TDP is now authorized to provide technical assistance (prefeasibility and feasibility studies and technical symposia) but not training. In 1982, TDP financed a feasibility study worth $440,000 for the Tiansheng Qiao hydropower project carried out by Harza Engineering Company. The study led to more than $20 million in U.S. exports for the project. A number of firms were involved in these exports. Another example is a $100,000 TDP study of a silicon materials plant that led to $8 million worth of equipment exports.

TDP also serves as the coordinating body for other U.S. agencies that provide technical assistance to friendly nations. In China the U.S. Geological Survey, for example, provides seismology equipment and technical assistance, and the Department of Energy provides technical assistance in planning for the Three Gorges project. TDP plans additional funding of studies of the Three Gorges project to assist a combined U.S. Government and private-sector effort.

TDP is particularly important because the United States has no formal aid program and therefore cannot provide concessional financing for large projects.[106] TDP funding is limited, but it can be strategically used to support early planning for key projects. In the context of budgetary constraints, the modest[107] but well-received TDP program is worth considering as a model for future Government efforts to promote technology transfer and trade. The success of its programs is clear in the strong support it receives from the U.S. business community. In recent years, however, MOFERT has identified more potential TDP projects than TDP funding can support. Table 25 provides an overview of TDP in China.

In addition to these U.S. programs, the United States also participates in multilateral programs via the World Bank and the United Nations that promote economic development and technology transfer to China. In both cases, U.S. contributions go to general funding rather than to specific programs in China. Nevertheless, such funding of multilateral programs provides the United States with indirect influence on projects in China that generally involve foreign participation.[108]

The multilateral organizations provide significant support for projects in China. The World Bank, for example, has granted loans

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[104] TDP also works with the Shanghai Municipal Economic Relations and Trade Commission.

[105] It should be mentioned that although a grant agreement is signed by TDP with Chinese organizations, no funds are transferred to China. TDP procedures call for the U.S. contractor to submit invoices to the Chinese party, who approves them and sends them to the U.S. Embassy in Beijing or the consulate in Shanghai, for transmittal to TDP in Washington, which authorizes payments to the contractor.

[106] In December 1985 President Reagan removed China from the list of countries disqualified to receive aid. The United States, however, has no current plans for an aid program in China.

[107] TDP has a staff of 16.

[108] The United States is the largest contributor to the United Nations Development Program and the single largest donor to the World Bank. The share of U.S. funding for such programs has, however, declined in recent years.

Table 25.—The Trade and Development Program in China

Project	Company	TDP Contribution
Completed studies:		
Guangdong Dairy Plant	China-Agro	$ 44,000
Tianshengqiao Hydropower	Harza	$400,000
Silicon Materials	Stearns Catalytic	$100,000
Maanshan Wheel and Tire	Rust Engineering	$200,000
Zhuhai Industrial Park	MK Ferguson	$162,000
Shenzhen Airport	Parsons/Lockheed	$800,000
Completed technical missions:		
Coal Ministry Review of U.S. Technology		$111,000
MOFERT Review of U.S. Technology		$ 40,000
Hydropower Protocol Technical Exchanges		$500,000
Ongoing studies:		
Yuxian Coal Gasification	Kaiser/Lummus	$750,000
Shanjiasi Heavy Oil Reservoir	SAIC	$280,000
Huangling Coal Mine	Kaiser/Consolidated	$550,000
Maanshan Energy Conversion	IIEC	$250,000
Capital Hospital	American Hospital Supply	$200,000
Automotive	GM	$200,000
Xinhua News Agency	Phoenix Associates	$350,000
Meishan Multichannel Carr. Eq.	Pacific Telesis	$410,000
Xian High Voltage	Power Tech Inc.	$460,000
Wujing Trijeneration	Bechtel	$460,000
Power Plant Conversion	Burns and Roe	$600,000
Zinc and Aluminum Castings	Kiowa	$150,000
Steel Building Systems	Thyssen	$150,000
Shanghai Cement	Kaiser	$150,000
Shanghai Solid Waste Disposal	Klockner	$250,000
Shanghai Corn Fermentation	under selection	$425,000
Shanghai Petroleum Coke	under selection	$325,000
Ansai Oil Field	CER	$650,000
Liuhu Oil Field	Core Laboratory	$500,000
Shenyang Toxic Waste	under selection	$325,000
Flue Gas Desulfurization	under selection	$143,000
Shanghai Transportation	under selection	$380,000
Graphite Electrodes	under selection	$150,000
Baoshan Management Information	under selection	$650,000
Zhongyan Pharmaceutical	under selection	$400,000
Sichuan Gas	under selection	$550,000
Automotive Sector	under selection	$500,000

SOURCE: TDP, August and November 1986, data supplied to the Office of Technology Assessment.

for more than 40 projects in China. In the spring of 1986, the International Development Association of the World Bank announced that $230 million in credit would be made available to assist China in expanding railways in four southern provinces. The World Bank may supply $2 billion on concessional terms during the next 5 years for projects in China.[109] China is making its first credit tranche from the IMF, borrowing more than $700 million.

Multilateral development banks offer opportunities for U.S. exporters that are not fully utilized. A recent study indicates that the U.S. share of procurements from these banks has declined from 29 to 23 percent of the total over the past decade, while Japanese firms have had considerable success. Total procurement worldwide that is financed by these banks amounts to $15 billion annually. A recent study concludes that U.S. firms could do much better in procurement from these sources, particularly in equipment supply and construction.[110]

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[109] Elizabeth Morrison, "Borrowing on World Bond Markets," *China Business Review*, January-February 1986, p. 18.

[110] Bretton Woods Committee, *How U.S. Firms Can Boost Exports Through Overseas Development Projects*, October 1986.

One factor could be that the U.S. Government offers less financing and other forms of support for such projects than do other nations.

Issue: Should the United States Use "Mixed Credits"?

The United States has traditionally opposed mixed credits (financing that combines official export credits and concessional aid) on the basis that this is a "predatory" type of financing that tends to distort trade. Current U.S. policy is to use mixed credits only to counter those of other supplier countries and to support the recent agreement among OECD countries to regulate the use of such financing. Some critics argue that such restrictions effectively put U.S. business at a disadvantage during a period when trade competition is increasing.

The United States has not used mixed credits to finance projects in China, and there is no consensus as to whether it should. On the one hand, some do not accept the notion that U.S. firms are losing export opportunities in China because of inadequate official financing. In recent years, the ExIm Bank has rarely utilized all of its available resources.[111]

One counter to this argument is that extensive official export financing provided by their Government has helped Japanese, French, Belgian, Swedish, and other firms win contracts in China. The use of export credits in financing for projects in developing countries is, moreover, increasing.[112] The U.S. Government could send a signal to exporters by making more official financing available for China.[113] Enlarging the amount of official U.S. financing programs would not contravene the agreement reached among OECD countries.[114]

The policy dilemma is that U.S. firms may find themselves less competitive if the United States does not offer mixed credits; but if the United States uses such assistance, other countries can be expected to do likewise. The result would be to "spoil the market" by raising the level of supplier country subsidies to financing.

The United States established a "war chest" in the ExIm Bank in 1986 to help U.S. firms compete against foreign firms supported by mixed credit financing. ExIm officials stated in April 1987 that the bank would probably not use all of the war chest in 1988, because of the OECD agreement on mixed Credits.[115] To the extent that the agreement makes it more expensive for governments to offer such financing, the result may be to reduce the use of mixed credits. One potentially important effect of the OECD mixed credit agreement may be to improve reporting on the use of such credits, thereby improving the information base needed to formulate government policy responses.

On the other hand, a number of supplier countries have announced plans to expand official financing programs, and aid programs may also be expanded. In expanding its aid programs, Japan has stressed that untied aid will be given, permitting firms from other countries to participate.[116] *Export financing will likely remain an area of intense competition among the supplier governments.*

Issue: Should the United States Establish an Aid Program for China?

Mixed credits raise the question of whether or not the United States should have an aid program for China, because aid-type concessional financing is the source of funding often used in conjunction with official (ExIm-type) funding. The legal prohibition has been removed on a U.S. aid program in China.[117] To many, this is a largely symbolic step that shows that the United States sees China as a "friendly" country.

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[111] There are a number of possible explanations for this, including the fact that high interest rates in the United States have, up until recently, made such financing less attractive than that of other suppliers. ExIm officials may also not see it as appropriate to initiate discussions with U.S. exporters, who may in some cases be unfamiliar with services that it provides.

[112] The IMF concludes that "Over the near term, it is expected that officially supported export credits will continue to play a growing role in catalyzing financial flows to developing countries." See Edward Brau, et al., *Export Credits: Development and Prospects* (Washington, DC: IMF, July 1986), p. 2.

[113] Statements by ExIm officials in late 1986 indicated a step in this direction; they stated that a number of China projects were under consideration.

[114] The OECD arrangement stipulates the terms of the loans.

[115] See "Eximbank will not need all of its "war chest" funding as a result of OECD Accord, Bohn Says." *International Trade Reporter*, Apr. 1, 1987, p. 436. The bank requested $100 million for fiscal year 1988.

[116] The ability of foreign firms to participate will depend on whether they are fully informed of such opportunities and their willingness to compete for these contracts.

In the context of reduced funding for foreign aid worldwide by the 99th Congress, the question arises about whether bilateral assistance programs will be expanded.[118] In a period when the United States cannot meet commitments to some developing countries (mainly in sub-Saharan Africa), some in the aid community would question whether an aid program for China is warranted. Proponents would have to make the case that a China aid program is more important than aid programs in other countries. In addition, there would have to be a clear signal of interest from China.

Advocates can raise a number of arguments in favor of an aid program in China. If carried out effectively, aid funds could assist China in programs that do not promise great profits for private-sector firms. Support for "basic human needs" has been the central pillar of aid's philosophy. Aid projects could be a mechanism for deepening the involvement of U.S. firms and organizations at the grass roots level in China.

China is unlike other developing countries where large aid programs have been established in that it still has comparatively large foreign exchange reserves. A large aid program involving economic support funds would not provide the transfers of technology that China's leaders emphasize. *If an aid program is established, it is more likely to take the form of a low-key, modest approach that supports technical assistance and training. Under those conditions, only small amounts of funding would be available to support mixed credits.*

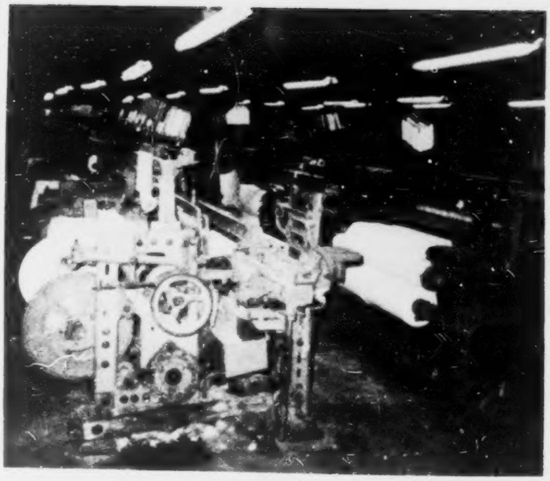

Photo credit: Carol Rupprecht

A recently installed loom in a village factory in Shandong Province. This enterprise is an example of an important trend—increasing industry in rural areas absorbing excess farm labor.

Many aid projects worldwide (such as those involving technical assistance) include participation by U.S. firms. But commercial gain has not, in the past, been the major ostensible goal of U.S. aid programs. Rethinking aid's overall objectives would thus be needed in order to reorient programs toward commercial objectives, and this would be resisted by many who believe that the aid should remain geared to helping the "poorest of the poor." As discussed above, TDP is already playing a critical role today in coupling U.S. commercial interests with Chinese development needs.

If U.S. policy makers decide to establish a formal aid program, the "Spark Program" plan (discussed in ch. 3) offers opportunities.[119] The program is designed to create a vibrant industrial sector in China's smaller cities. The Spark program is not one in which most U.S. technical agencies are likely to have an interest, and it would be difficult for American companies to learn about commercial opportunities associated with it. Yet, there is a great deal of development experience in U.S. agencies and the private sector that might be shared with the Chinese in a mutually beneficial way if new funding sources were available.

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[117] However, before initiation of such a program the Department of State would have to provide certification concerning human rights practices.

[118] See Society for International Development, *Development Connections*, December 1986, p. 2.

[119] The most complete explanation of the objectives of the Spark Plan is found in the recently released "Science and Technology White Paper" (in Chinese), a translation of which is forthcoming from the Joint Publications Research Service.

Issue: What Could the U.S. Government Do To Promote Trade and Technology Transfer?

U.S. promotional programs influence the scope and nature of technology transfer and exports to China, although it is important to remember that trade finance, for example, is only one element affecting U.S. competitiveness in foreign markets. As discussed more fully in chapter 5, U.S. trade finance and promotional programs are not as extensive as those of some other supplier countries, such as Japan. Other Governments use aid as well as more extensive official export financing to assist exporters.

In view of the decline in U.S. market share in China, *a key question for U.S. policy makers is whether U.S. promotional programs and policies are adequate to meet the challenge of global competition in the decade ahead.* In years past U.S. officials have taken the view that it is enough for Government to negotiate agreements on fair rules of the trade game, while ensuring that national security is protected through controls on sensitive exports. In the future, U.S. policy makers may want to explore new avenues for trade promotion.

The United States could do more to assist firms and organizations exporting equipment, services, and technology. Relatively modest dollar investments in project planning have significant trade multiplier effects. Such programs sponsored by TDP could be expanded. FCS and other Government agencies could also take a stronger lead in reaching out for new projects and in combining financing from a number of sources (public and private) for large projects. Developing sector-specific plans for exports could also be useful, particularly if the result is greater consistency between U.S. export controls and promotional policies. In the past, U.S. export controls and promotional policies have been developed independently, and in some areas (such as telecommunications) this has created confusion.

More specifically, the following options could be studied:

1. expand funding for TDP feasibility studies and provide TDP with authorization to support training programs in China;
2. enlarge FCS representation in China;
3. increase efforts to combine financing from various public and private sources;
4. provide information and financial resources to support participation by U.S. firms in projects funded by multinational development banks;
5. expand official financing and guarantees for loans and investments in China; selectively utilize "soft" financing for projects in China where other Governments have provided such financing;
6. develop trade promotion strategies for particular export sectors by combining the resources of various U.S. Government agencies and clarifying export control questions; and
7. establish mechanisms and institutions (that include public and private sectors) for continuing dialogue and consultation between China, the United States, and other major trading partners in order to anticipate problems and seek mutually beneficial solutions.

A high-level mandate would be needed to develop a coordinated and active approach to U.S. trade promotion. Any of the measures listed above, taken alone, would be unlikely to have a significant impact. Other policies that affect the technological capability of U.S. firms and exchange rates are also critical to the overall strength of U.S. exporting firms. *Programs of trade promotion, disembodied from a coherent overall U.S. strategy promoting the competitiveness of U.S. industries in foreign markets, are unlikely to yield significant results.*

Issue: What Choices Does the United States Have in Its Trade Policy vis-à-vis China?

U.S. trade policy has been oriented in the postwar period toward promoting a global trading system in which firms from many countries can compete fairly. Developing countries have been given special preferences in trade to foster their economic development, which in turn provides export opportunities for the developed countries.

To these ends, the United States has taken a leadership role in establishing multilateral financial institutions such as the IMF and assistance programs such as those of the World Bank. Many of these institutions were built during a period when American economic and military power were preeminent, and U.S. leadership was viewed as natural.

The structure of international trade has changed, and today U.S. firms must work hard to compete against competitors in developing as well as developed countries. Wide-ranging legislation is under consideration in Congress, where concern about import penetration and the overall U.S. trade deficit runs strong. Under pressure from Congress, the administration has made efforts to demonstrate its willingness to aggressively investigate unfair trading practices that hurt U.S. industry.

U.S. trade policy vis-à-vis China reflects these broader tensions and choices. The International Trade Commission initiated 15 antidumping investigations involving imports from China during the 1980-85 period, and in 9 of those cases antidumping orders were made. In 1985 alone there were four antidumping investigations involving goods from China, and in three cases there was a finding of injury to U.S. industry.[120] Growing Chinese textile imports have, as mentioned earlier, led to bilateral frictions and repercussions in other areas, such as U.S. grain exports.

Frustrations with import penetration in the United States could lead to protectionist responses. But such actions could also stimulate retaliatory actions by China. Because China's exports are so strongly concentrated in the textile sector, actions taken to protect U.S. producers (and without specific attention to the significance of textiles in U.S.-China trade) would strongly affect China. If Chinese leaders were to retaliate by limiting imports from the United States, the result would be to limit bilateral trade. It is also possible that heightened political tensions could limit or reduce cooperation in other areas.

Trade is often viewed in a bilateral context. However, long-term solutions require that policy makers also consider the broader multilateral context. The policies of China's other major trading partners such as Japan affect Chinese export prospects. If other industrial countries erect barriers to Chinese exports, pressure on the U.S. market increases. Informal consultation among the United States, China, and other Asian traders could improve awareness of such interdependencies and perhaps stimulate constructive action.

China has announced its intention to join the GATT, a step toward integration into the world trading system. (This process began earlier with China's participation in other international organizations such as the IMF and the World Bank.) China's entry into the GATT raises issues for U.S. policy makers and other GATT members who will participate in the formal review of the application. To join the GATT, China may need to relinquish certain trade barriers and open its system more to imports. U.S. officials and others will have to carefully review Chinese restrictions that limit the activities of foreign businesses, including stipulations concerning local content and export requirements. In the process, it will also be necessary to review current U.S. policy to withhold Generalized System of Preferences status[121] on the grounds that China is not a GATT member.

In the near future, U.S. policy makers will consider a number of trade and competitiveness policy alternatives that have important implications for U.S.-China trade. Traditionally, the alternatives have been defined as "free trade" versus a protectionist response to import penetration by developing countries. With regard to China, U.S. policy makers could alternatively aim to deepen bilateral economic relations. A bilateral strategy would emphasize an expanding U.S. market share in China while minimizing frictions associated with increasing imports of certain types from China. To some who believe that free trade is today more an ideal than a reality and who fear the costs of a protectionist response (in higher prices for the U.S. consumer and potential loss of U.S. influence abroad), bilateral initiatives may be appealing.

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[120] In 1983 and 1984 there were similar numbers of cases involving China. See U.S. ITC, Annual Reports, 1983-85.

[121] Under the Generalized System of Preferences, special trade treatment is provided to developing countries by developed countries.

U.S. programs supporting technology transfer to and trade with China, to be effective, should relate to a broader global trade and competitiveness strategy. Controversy continues over the broad goals of U.S. trade policy, and uncertainty may be created among U.S. exporters and Chinese buyers that leads to continued stagnation in U.S.-China trade. While it is true that U.S. Government policies alone may not dramatically increase U.S. exports to China in the short term, a new attitude (shared by business and Government alike) toward global competition may be needed to forge a viable, positive, long-term strategy. From this perspective, China is a test of U.S. competitiveness in the developing country market.

CONGRESSIONAL CHOICES

The United States and China are now entering a new phase in their relationship, and it is appropriate to consider the challenges that lie ahead. In the past, U.S. policy was designed to promote an opening of relations between the two countries consistent with U.S. security, commercial, and other objectives. Now that the foundation has been laid, Congress has an important role to play in evaluating the success of current U.S. China policy and in setting future goals and directions. The absence of a crisis in U.S.-China relations makes this a good time to consider actions that Congress and the U.S. Government could take that would significantly affect the scope and nature of technology transfer and trade between the United States and China, and OTA's research highlights actions that Congress might consider.

OTA finds general agreement in the United States that economic relations with China should be expanded in the current policy context. Concerns that China's modernization could have potentially negative effects on other countries in Asia and uncertainty about the future course of China's policies, especially in light of recent student demonstrations and shifts in leadership, have not weakened this consensus. Liberalization of controls on exports to China, both in the United States and in COCOM, has been well received.

But agreement on general principles does not constitute a coherent policy. In reviewing U.S. policies toward China, Congress may want to consider whether the proper balance among the five major themes identified at the beginning of the chapter has been established. Another question is whether the United States is effectively using all of the policy instruments available to maximize U.S. interests. Ad hoc decisionmaking on export controls, for example, can produce inconsistent decisions and an uncertain policy context.

During 1986, controversies over China export controls somewhat receded in the wake of loosened restrictions in the United States and COCOM. The process of license approval has been accelerated for many types of equipment and technology covered by the green zone agreed to by COCOM countries. On the other hand, export license applications that must be referred to other agencies and to COCOM still require a long time for review. There are no clear guidelines concerning prohibited exports; case-by-case reviews of military and sophisticated dual-use exports remain the focus of controversy and debate. There are thus a number of reasons why Congress may wish to review China export controls in the months ahead.

One goal of such a reexamination would be to make the system operate more efficiently.

Photo credit: Alan T. Crane

Modern buses parked by an old but still important canal in Suzhou. Famous for its gardens, Suzhou is also a major manufacturing center.

Another goal would be to revise and shorten the list of controlled items to reflect changes in technology and foreign availability while focusing the attention of the export control system on militarily significant items and technologies. These efforts require coordination with COCOM allies. Clearer guidelines specifying which types of military or advanced dual-use equipment and technology cannot be exported could also be developed for use within the U.S. government. Congress and its committees of jurisdiction on export controls have a critical role in these decisions as well.

Congress may wish to consider actions to refine the system of export administration by: 1) tighter administration of existing policy, 2) through modifications within the current policy framework, or by 3) considering actions that would constitute new policy approaches. The possible actions listed below are grouped according to those categories.

Refine the export administration system, by considering the following possible actions:

1. Tighter adminstration of existing policy:
   - —require periodic reviews from the Operating Committee concerning China cases under interagency review for protracted periods;
   - —require DOC to provide more timely information to the public and to Congress about the status of China licensing, particularly concerning the value, status, and nature of exports approved in referred China cases;
   - —support expanded use of automated sys-

tems in order to improve the efficiency of export licensing and to increase consistency in decision making by expanding the accountability of license examiners;
   - —carefully monitor DOC progress in attaining the goal of processing China licenses (IVLs) in 45 days by July 1987, and set a target, such as 6 days, for processing green zone cases;
2. Modifications within the current policy framework:
   - —break the deadlock in interagency reviews of China cases by amending the Export Administration Act to give DOC final authority to approve an application unless DoD *formally* appeals to the President with objections;
   - —require that DOC remove from active consideration (automatically approve) export applications that have been under review for more than 6 months (such cases could be automatically approved unless the Secretary of Commerce provides the exporter with a written explanation of why the case requires extended policy review);
   - —require that DOC, in consultation with DoD, the State Department, and other relevant agencies, develop clearer guidelines for use within the U.S. goverment that would specify types of exports to be prohibited (red zone);
   - —require that DOC, in consultation with the State Department, DoD, and other relevant agencies, develop by the summer of 1987 detailed, sector-specific proposals for expanding the green zone while continuing to preserve Western security;
   - —improve information exchange between officials reviewing U.S. munitions exports to China and those reviewing dual-use exports in order to ensure consistency;
   - —establish a distribution license procedure for China exports
3. New policy approaches: establish the general principle that the United States will work with COCOM allies to establish uniform controls for China and to harmonize export control administrative procedures in various COCOM nations. This would require that the United States relinquish unilateral controls for China if other COCOM countries cannot be persuaded within a reasonable period of time that they are justified, and that the United States, along with other COCOM countries, eliminate gaps in controls—such as different approaches to controls on re-exports.

Barring dramatic changes in China's relations with the Soviet Union or Taiwan, the most challenging problems may arise in the trade arena. There are a number of potential points of friction. China's exports are heavily concentrated in textiles—a threatened U.S. industrial sector. Other trade-related problems concern China's entry into the GATT and other international institutions. The United States and other GATT members will review China's trade and technology transfer regulations to determine whether they are consistent with the GATT. In still another area, there is a need for consultation and agreement among the United States, Western Europe, and Japan to minimize restrictions on imports from China that shift the burdens of adjustment to partners, and cutthroat competition for contracts with "soft" financing.

The United States could benefit from a positive approach to promoting U.S. exports and helping China improve its technological and managerial capabilities. Outlining the possible congressional actions needed to forge a new consensus on U.S. competitiveness is beyond the scope of this study, but nevertheless directly relevant to U.S.-China relations. Whether or not the 100th Congress carries out a full-scale review of U.S. policies toward China, it will importantly influence relations with that country through its trade policy.

The possible steps outlined below are grouped according to whether they would involve: 1) expanded use of existing programs, 2) modifications within the current policy framework, or 3) new policy approaches.

Develop an activist trade promotion strategy in order to improve U.S. competitiveness and ensure fair trade by considering the following possible actions:

1. Expanded use of existing programs:
   - —expand funding for TDP feasibility studies and training programs;
   - —support enlarged FCS representation in China;
   - —expand official financing for loans and guarantees, selectively using "soft" financing to counter such bids by foreign suppliers;
   - —continue support for multinational development banks and encourage DOC to provide U.S. firms with additional information so that they can win procurements:
2. Modifications within the existing policy framework:
   - —encourage the development of sectoral strategies for promoting trade with China (in line with U.S. export controls);
   - —request the State Department to prepare a review of government-to-government programs under the S&T protocols in order to determine which ones could now be left to private-sector action and which would require additional government support;
   - —encourage DOS and other U.S. Government agencies involved in S&T protocols to work for expanded access by U.S. scholars and technical personnel to Chinese research institutions, including those in rural areas;
   - —require that the Office of the U.S. Trade Representative (USTR) report to Congress on the review of China's application for entry into the GATT;
   - —improve mechanisms for informal consultation on Asian trade among the United States and other countries;
3. New policy approaches—initiate an official development assistance program for China that promotes expanded exports of U.S. goods and services.[122]

Many of the options above would require executive action. Congress can, through its oversight of executive branch programs, encourage this process. On the other hand, it may no longer be necessary for the Federal Government to play such a direct role in coordinating technical exchanges. Private organizations and firms, as well as State and local governments, are now independently involved in scholarly and technical exchanges. OTA's research indicates that there are a number of possible government actions to refine the system of export administration and to promote trade and technical cooperation with China that could contribute significantly to the development of deeper and mutually beneficial relations between the United States and China.

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[122] Earlier in this chapter, where the issue of an aid program for China is discussed, OTA notes the obstacles to the development of an export-oriented aid program.

APPENDIX C: EXPORT LICENSES PENDING OVER EAA STATUTORY LIMITS

In January 1987 OTA analyzed contributing factors in review process delays by examining cases that were pending beyond the statutory limits. The total number of these cases was 536, valued at more than $730 million dollars. Only a small number of these cases were cases that had not been referred to other agencies. A significant number were pending in the Coordinating Committee (COCOM), but the overwhelming majority of the cases had not been referred to COCOM but were under review in the inter-agency process.

Table 1.—Numbers of Cases Pending Over Statutory Limit

Type of case	Number of cases	Percentage
Non-referred cases	69	13
COCOM cases	124	23
Cases in interagency review	343	64
Total	536	100

Most of the cases (over 90 percent) had been pending for more than 120 days. These cases also accounted for 99 percent of the dollar value of all pending cases.

Table 2.—Processing Times and Values

Processing time (days)	Number of cases	Total value
61-75	18	$ 530,623
76-90	17	1,745,773
91-105	15	2,953,609
106-120	3	34,365
over 120	483	724,748,811
Total	536	$730,013,181

The 20 oldest cases had been in the system for 700-1169 days. All of those cases except one had been referred to the Operating Committee (OC) at one point, but only three of those were currently waiting for a determination by the OC. Of these cases, 12 had previously been under review by OC, but after OC made a determination, they were sent to the Department of Defense (DoD). In most of those cases, DoD made a recommendation and sent them back to the Department of Commerce (DOC), where they continued to await final determination. Many of the cases pending for the longest periods were under OC consideration. Particularly striking was that a large number of cases were sent back to DoD rather than referred to higher inter-agency review *after* OC completed its review.

Only a handful of the pending cases were actually under review by DoD at the time the data was collected. However, 430 of them had been reviewed by DoD at some point. About half of those 430 cases had been under DoD review for more than 300 days. Many of these had been resubmitted to DoD for review, some as many as four times. Generally speaking, DoD reviews did not account for the major part of total processing time for these cases. In many instances where cases were pending for long periods, however, they moved back and forth between DOC and DoD, and were not sent to the OC or other higher levels of review in the formal interagency review process.

Inputs from intelligence agencies is another aspect of interagency review that generally added a month or more to the processing time. Of the pending cases over the statutory limit, 237 involved such review.

It should be noted that OTA did not evaluate the military criticality of the technology that was under review, since this would have required study of complete license applications.

OTA's analysis suggests that exporters as well as licensing officers would benefit from more information concerning the type of technology that has recently been approved for export. Unnecessary delays arise when licensing officials lack complete information concerning precedent-setting cases. The kinds of information that would be useful to exporters include the dollar value and types of technology and equipment approved for exports. Online information concerning precedent-setting cases (such as those completed after extensive inter-agency review), case history information, and improved access to relevant information compiled by other agencies could improve the ability of licensing officers to make timely, consistent decisions.

Providing more information to exporters would require that certain proprietary or sensitive information (e.g., equipment models, applicants names, end users, and end use) be omitted from public dissemination. Brief, periodic summaries of generic types of technologies recently approved for export could reduce uncertainty for U.S. exporters. These data are readily available from the DOC computer systems (ECASS).

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